THE RELATIONSHIP BETWEEN MODELS OF STUDENT LAPTOP COMPUTER USE AND TEACHER INSTRUCTIONAL BEHAVIOR

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This study investigated the relationship between four models of student laptop computer use and three components of teacher instructional behavior: planning, implementation of instruction, and evaluation of instruction. The four models of use: full access, dispersed, class set, and mixed, represented the numerous ways teachers in public and private schools and school districts nationwide implemented student use of laptop computers. Teacher planning behavior was investigated with regard to time, frequency, complexity, difficulty, the need for revision, and use of technological resources and materials. Implementation of instruction was examined with regard to student grouping, instructional strategies, instructional content/subject matter, teacher and student roles, assignments and learning tasks, and instructional activities. The evaluation of instruction component was examined with regard to assessment tasks, grading, and assessment of homework.

Using a researcher-designed questionnaire, data was gathered in a single-stage cross-sectional survey from 356 teachers working in 74 public and private schools nationwide.

Results indicated models of student laptop computer use had differential effects on teacher instructional behaviors. On average, teachers found planning to be more arduous, but more collegial, especially in the mixed model. The full access and mixed

models were more likely to advance a constructivist approach to teacher instructional behaviors with regard to implementation and evaluation of instruction.

Results from this study had implications for future research. The effects of student laptop computer use on the full access and mixed models of use should be given further study with regard to the implementation and evaluation of instruction.

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CHAPTER I

INTRODUCTION TO THE STUDY

Throughout the 20th century, technological innovations entered the education system with the promise of revolutionizing education. In 1922, Thomas Edison expressed his sentiments when he stated, "I believe that the motion picture is destined to revolutionize our educational system and that in a few years it will supplant largely, if not entirely, the use of the textbook," (Cuban, 1986, p.9). That same year, educational radio stations were licensed and classroom broadcasting began to enhance classroom instruction. Although the use of radio in the classroom became widespread in the years prior to World War II, teacher instructional practices were basically unchanged.

Reminiscent of its technological predecessors, television also failed to revolutionalize education. Throughout the ensuing decades, television broadcasts were developed for educational programming much as radio was in earlier decades. Like radio, television was used as a media aid to enhance classroom practice. Radio, television and film were used as audio-visual aids. Instructional practices had not changed in decades. Quite simply, teachers had designed practical solutions, which "concentrated on transferring knowledge, skills and values to students through the teacher lecturing and questioning while the student listens and answers, and through reading textbooks and performing chalkboard and in-class work," (Cuban, 1986, p. 3).

When computer technology first arrived in classrooms in the 1970's, problems with hardware, software, accessibility, and costs prevented widespread acceptance among

teachers. Once again, the promise of a new technology did not materialize, and teachers continued to teach with little change in classroom instruction. Two decades later, when the early problems associated with computer technology were no longer issues, the presence of computer technology in American classrooms became more commonplace. Teachers and students began to embrace computer technology as accessibility to it increased. Craig Jerald (1998) reported that three out of every four U.S. public school classrooms had at least one computer designated for instructional use; multimedia computers accounted for 45 percent of all computers in the public schools; and the ratio of students to multimedia instructional computers dropped from 21 in 1997 to 13 in 1998; and almost half, 44 percent, of all classrooms had access to the Internet. Of the 85 percent of schools connected to the Internet, Jerald stated that 58 percent had access from at least one classroom, 54 percent had access from the computer lab, and 70 percent had access from the library/media center. A 1998 survey commissioned by *Education Week,* reported that at least half of the faculty in 47 percent of the schools surveyed in the 50 states used computers daily for instructional planning and/or teaching ("How Technology is Used," 1998). Students using computers as part of their educational programs were becoming a more familiar sight.

Educators began to experience technology challenges of a different sort—use and equity. Because computer technology was frequently located in computer labs and/or library/media centers, some educators raised the issues of equality of student opportunity and degree of access. Anderson and Ronnkvist (1999) noted that students and teachers were not able to effectively utilize computers for learning if they were not placed in

particular classrooms. Likewise, Becker and Sterling (1998) noted that placing computers outside classrooms made it more difficult to integrate computer activities into the learning experiences of students in that having too few computers in one place made it difficult to orchestrate learning activities for a classroom of students. Moreover, some students had computers in their homes while others did not. Solving the issues of equity and access led many schools and school districts to adopt the use of laptop computers.

Much has been learned from the wide variety of topics related to computer technology that has appeared in the growing body of literature. Many studies examined the integration of computer technology with curriculum (e.g., Buchanan, Luck, & Dulniak, 1996), professional technology training and support for teachers (e.g., Schmidt, 1996), computer use (e.g., Weiss, 1996), the relationship between computer technology and student learning (e.g., Dwyer, Ringstaff, & Sandholtz, 1991), student achievement (e.g., Becker, H. J., 1987) as well as the relationship between computer technology and teacher roles (e.g., Civello, 1999). One landmark study, Apple Classrooms of Tomorrow (ACOT), was a ten-year qualitative study begun in 1985. Conclusions specified teacher beliefs, management, instructional strategies, and student assessments changed over time as a function of technology use (Fisher, Dwyer & Yocam, 1996). More specifically and pertinent to this proposed study, is that technology acted as a catalyst for the changes in teacher beliefs, which, in turn, brought about changes in instructional strategies and classroom management. Learning became more student-centered as well as interactive. Students were given more responsibility for their learning and became more independent

learners. Teacher instructional behaviors changed and became more constructivist in the presence of computer technology.

With the increased prevalence of computer technology, the body of research pertaining to computer technology in education is emerging. Although issues such as computer use, integration of computer technology, curriculum, teacher role, beliefs and attitudes, learning environment and student learning are being addressed, no study has investigated the relationship between student laptop use and teacher instructional behavior.

Purpose of the Study

The purpose of this study was to investigate the relationship between four models of student laptop computer use: full access, dispersed, class set, and mixed, and constructivist teacher instructional behavior. The independent variables, the four models of use: full access, dispersed, class set, and mixed, represented the numerous ways teachers in public and private schools and school districts nationwide that may or may not participate in Anytime, Anywhere Learning (AAL) implemented student use of laptop computers (Toshiba, 1998). The dependent variable, teacher instructional behavior, had three components: planning, implementation of instruction, and evaluation of instruction. Teacher planning behavior was investigated with regard to time, frequency, complexity, difficulty, the need for revision, and use of technological resources and materials. Implementation of instruction was examined with regard to student grouping, instructional strategies, instructional content/subject matter, teacher and student roles, assignments and learning tasks, and instructional activities. The evaluation of instruction

component was examined with regard to assessment tasks, grading, and assessment of homework. Each area was important to this study because it is a component of teacher instructional behavior.

Research Questions

Research question 1: What characterizes teacher planning behaviors with regard to time, frequency, complexity, difficulty, need for revision, and use of technological resources and materials when students use laptop computers in one of four models of use: full access, dispersed, class set, or mixed?

Research question 2: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher planning behaviors with regard to time, frequency, complexity, difficulty, revision, and use of technological resources and materials?

Research question 3: What characterizes teacher implementation of instruction with regard to student grouping, instructional strategies, instructional content/subject matter, teacher and student roles, assignments and learning tasks, instructional activities, instructional materials, and student and teacher interactions when students use laptop computers in one of four models of use: full access, dispersed, class set, or mixed?

Research question 4: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to student grouping?

Research question 5: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop

computers and teacher implementation of instruction with regard to instructional strategies?

Research question 6: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional content/subject matter?

Research question 7: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to teacher and student roles?

Research question 8: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to assignments and learning tasks?

Research question 9: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional activities?

Research question 10: What characterizes teacher evaluation of instruction behaviors with regard to assessment tasks, grading, and homework assessment when students use laptop computers in one of four models of use; full access, dispersed, class set, or mixed?

Research question 11: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to assessment tasks?

Research question 12: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to grading?

Research question 13: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to homework assessment?

Operational Measures in the Study

The independent variables in this study were the four models of student laptop computer use: full access, dispersed, class set, and mixed. The dependent variables in this study were the researcher-defined components of teacher instructional behavior: planning, implementation, and evaluation of instruction. Planning for instruction was examined with regard to time, frequency, complexity, collegiality, difficulty, need for revision, and use of technological resources and materials. Implementation of instruction was examined with regard to student grouping, instructional strategies, instructional content/subject matter, teacher and student roles, assignments and learning tasks, and instructional activities. The evaluation of instruction component was examined with regard to assessment tasks, grading, and assessment of homework.

Limitations

This study was limited by the use of a researcher-designed instrument. A pilot test of the Teacher Questionnaire was conducted. It included 20 teachers whose students used laptop computers. After data collection, the questionnaire's internal reliability was established using Cronbach's Alpha. However, the Teacher Questionnaire was not psychometrically validated. Rather, it was intended to provide impetus for additional research.

Definition of Terms

Teacher instructional behavior was defined as any behavior related to the teacher's planning, implementation of instruction, and evaluation of instruction.

Evaluation of instruction was defined as the activities and tasks including grading as well as homework assessment used by teachers to assess student learning.

Full access model was one in which each student had a laptop computer for his/her use at all times, both at home and school.

Dispersed model was one in which laptop computers were dispersed throughout a grade or school. Thus in any given class, there would be students with laptop computers and students without laptop computers.

Class set model was one in which a school or school district had sets of laptop computers available for teachers to check out for specific periods of time during which all students had laptop computers. (Students may or may not be able to take laptop computers home for use.)

Scattered model was one in which a school or school district distributed a few laptop computers to each classroom within the school or district with little opportunity for students to take the laptop computers home.

Mixed model was one in which a school or school district combined two of the models either within or between schools.

Significance of the Study

. The significance of this study was its potential to further the research between the relationship of student laptop computer use and teacher instructional behaviors. No studies had examined the relationship between student use of laptop computers and teacher instructional behaviors. Although current research indicated that teachers modified their instructional behaviors when students share desktop computer technology in the learning environment, this may or may not be the case when student use of laptop computers occurred in the learning environment. Determining if teacher instructional behaviors differed between models of student laptop computer use may provide some insight into how to better prepare teachers to integrate technology into their instructional practice when students use laptop computers. As more and more private and public schools and school districts in the United States adopted the use of laptop computers for students, training and supporting teachers who teach these students became paramount. In many colleges of education, teaching with technology was becoming more important in the preparation of pre-service teachers. Hence, this study may contribute to the growing body of knowledge concerning the preparation of pre-service teachers as

well as the training and support of in-service teachers whose students use laptop computers.

CHAPTER II

REVIEW OF RELATED LITERATURE

Since student use of laptop computers was relatively recent, the research background related to this topic was sparse. Therefore, the review of related literature focused on establishing a theoretical perspective related to teacher instructional behaviors as well as to research related to computer technology in education. The propositions of constructivist learning theory set the stage for characterizing teacher instructional behaviors in the presence of computer technology. This chapter begins with this theoretical perspective followed by a review of the related literature and concludes with the reports of two qualitative investigations of Anytime, Anywhere Learning (AAL).

Theoretical Perspective

Recently referred to as a learning theory, constructivism provides the theoretical perspective for this study (Beihler & Snowman, 1997). Drawing heavily from the work of Jean Piaget and Lev S. Vygotsky, constructivism emphasizes the developmental and social nature of learning, the two underlying propositions of constructivist theory. As demonstrated in Piaget's theory of cognitive development, the growth of intellect progresses through distinct stages of development requiring interaction with one's environment. Both Vygotsky and Piaget believed such cognitive change takes place when previous conceptions go through the process of disequilibration (as defined by Piaget) in view of new information. The proposition that learning is social in nature is based on four key principles from Vygotsky's work. First, the nature of learning is social (Hickey,

1997; O'Connor, 1998; Salomon & Perkins, 1998). Learning takes place through interaction with one's peers, more capable peers, and/or adults. Interacting with one's classmates exposes learners to the cognitive processes of more capable peers and adults. Thus, cognitive processes (inner speech) and learning outcomes are available to all students. The second key principle is the zone of proximal development which simply means that learners learn best when they are engaged in a task(s) that draw upon their prior knowledge, but also requires the assistance or guidance of a more capable peer or adult. The third principle, cognitive apprenticeship, emphasizes the social nature of learning as well as the zone of proximal development (Gardner, 1991; Greeno, Collins, & Resnick, 1996). Cognitive apprenticeship is akin to the apprenticeship of learning a trade from an expert. The learner works with an expert, adult or more advanced peer, and gradually acquires expertise. Mediated learning or scaffolding is the last key principle drawn from Vygotsky's work. Scaffolding refers to the "supports" for learning created by teachers when presenting students with complex, difficult, but realistic learning tasks. Current thought stresses the notion of top-down processing where students are presented with complex tasks rather than bits of knowledge that will one day build to a complex task (Slavin, 2000). Teachers guide instruction using scaffolds in order to help students master and internalize skills that allow higher cognitive functioning.

Much of the research involving constructivist learning theory focuses on the relationship between constructivist and traditional instructional strategies as well as their effects on student achievement. Airasian and Walsh (1997) and Harris and Graham (1996) concluded that the acquisition of skills and basic information must be balanced

with constructivist approaches to learning. Harris and Alexander (1998) and von Glaserfeld (1996) sought answers to the dilemma of appropriate balance as well as for which objectives. Other studies demonstrated positive effects of constructivist instructional strategies on traditional achievement measures in mathematics (e.g., Carpenter & Fennema, 1992), science (e.g., Neale, Smith, & Johnson, 1990), reading (e.g., Duffy & Roehler, 1986), and writing (Bereiter & Scardamalia, 1987).

Applying constructivist learning theory to this study has direct implications for the independent variables, the models of use. It is expected that the independent variables will be associated with differences in the dependent variables, planning, implementation of instruction, and evaluation of instruction. That is, if students use laptop computers, then teacher instructional behaviors will differ across the five models of use. Moreover, teachers may be more likely to implement constructivist learning theory when all students have full access to laptop computers.

Computer Technology and Teacher Instructional Behavior

As computer technology became more evident in American schools in the late 1980's, Howard Budin (1991) articulated his beliefs regarding the possible effects of computer technology on the classroom teacher's role. Budin provided an essential context for understanding the interaction between teacher role and computer technology by recounting the history of the teachers' role and their gradual loss of voice regarding what and how to teach since the mid 19th century. Three "visions" informed his discussion: replacement, implementation, and transformation. Rather than the usual notion of technology replacing the teacher, Budin suggested using technology to replace some

instructional practice as a logical extension of implementing technology. Most commonly, Budin suggested technology is seen as just another tool to supplement curriculum rather than change it. Instead of replacement and implementation, Budin conceived a vision where technology helps transform curriculum, teacher's role, and even school structure. Echoing the reform concepts of Dewey and others, Budin presented technology's potentials: communication with distant places, information access from new sources, collaboration and critical thinking, planning and implementing curricular projects, as a vehicle for renewing the visions of educational reform. Accordingly, achievement of such visions requires teachers to reclaim leadership regarding instructional decision-making as to what to teach and how to teach it in the classroom. They must develop and enact new instructional behaviors.

Riel (1989) investigated the changes that take place in teaching and learning when computer technology is incorporated into educational practice over the course of one academic year. The four experienced teachers were given one computer for use in their classrooms even though two of the teachers had no previous experience or training with computers. Although the remaining two teachers had extensive experience with computers, neither teacher had a computer available for classroom use. However, one of the teachers with computer experience had used computers in a lab setting for three years, used computers part-time for language arts and mathematics instruction, and currently had the responsibility of leading his school's computer lab. The other teacher with computer experience had an Apple II for classroom use part-time in the year prior to the study, and she had taught word processing classes through a university extension

program. Data for the study was collected through weekly teacher interviews throughout the academic year, and observers took notes in each of the classrooms three days a week. One to three times a month, specific types of lessons and computer sessions were videotaped. The results revealed changes in classroom environment, interactive patterns, and student learning, but neither the spatial arrangement of the classroom, the classroom time schedule nor the instructional behaviors of teacher was changed by the presence of the computer. Rather, the teachers used the computer to enhance their traditional instructional behaviors by using the computer to demonstrate concepts to the whole class, thus continuing their use of whole class instruction. Riel's study did not investigate teacher planning or evaluative behaviors.

Sheingold and Hadley (1990) surveyed teachers working in technology-rich environments who taught grades 4-12. Respondents perceived that their teaching changed in several ways, that is, teaching behaviors were transformed. Teachers perceived themselves as collaborators with their students, as facilitators of student learning, as more flexible problem solvers, and they felt better able to meet the individual needs of students. They credited the integration of computer technology as a catalyst and educational tool causing the shift from teacher-centered classrooms to student-centered classrooms, and they altered their vision of what students should learn and what their learning tools should be. However, neither teacher planning nor evaluative behaviors were investigated and descriptions of teacher instructional behaviors were expressed in broad generalizations. Sheingold and Hadley recognized that the survey methodology

could not validate the teachers' perceptions, however, they believed the high agreement among the respondents validated their reports.

The evaluation report of the Oakland County School project, Teaching and Learning with Technology (1991), utilized both qualitative and quantitative methodology to answer several evaluation questions: (1) In a technology-rich environment, how is technology applied to enhance educational goals? (2) What kinds of staff development programs result in the effective use of technology to accomplish curricular objectives? and (3) What is the impact of a technology-rich environment on teaching and learning? One control group technology-poor classroom was identified for each technology-rich classroom, one classroom each in grades 3-4-5. The technology-rich third grade classroom enjoyed computer technology at a ratio of three students for every computer while the fourth and fifth grade technology-rich classrooms benefited from a student to computer ratio of 2 to 1. Fourth and fifth grade teacher work stations in technology-rich classrooms consisted of an Apple IIGS, 20 megabyte hard drive, printer, modem and phone line, videodisc player, VHS videotape recorder and large TV monitor while an Apple IIGS with a 20 megabyte hard drive, printer, large screen TV monitor and VHS videotape recorder were given to the third grade teacher in the technology-rich classroom. Technology-poor classrooms had two computers and video access for every 25-30 students. Students remained in the technology-rich classrooms while in these grades.

Students were surveyed, interviewed, and tested. The treatment and control groups were pre and post-tested each year for three years using a variety standardized

achievement tests in language arts and reading. Additionally, control and treatment group students responded to a writing prompt at the beginning and end of each school year. Throughout the project, classroom observations occurred regularly. Students and teachers were surveyed at the conclusion of the project regarding school climate and morale, and technology respectively. Control and treatment group students were exit interviewed while treatment group students were interviewed at the beginning of the project to determine their level of technology expertise.

Evaluators reported several findings concerned with changes in teaching. Teachers perceived changes in their teaching characterizing themselves as more reflective and more likely to seek out research to learn more about educational processes including continuing their formal education. The teachers also noted changes in classroom structure, their instruction and interactions with students as well as their professional practice. Most significantly, the teachers reported not wanting to teach without technology. Evaluators reported student perceptions of the shifts in teacher's role by comparing non-project and project student comments regarding what teachers do in the classroom. In the technology-rich classrooms, student comments were interpreted to mean that teacher behavior was aimed a student's self-development where as teacher behavior in non-project classrooms was interpreted as directive or authoritarian. Teachers perceived changes in their classroom practices as a reflection of their attitudes and skills growth. They felt more able to tolerate ambiguity and shared ownership of the teaching-learning process with students. This project illuminated changes in teacher instructional

behavior and professional practice because of student use of computer technology, but there was no discussion of teacher planning behaviors or evaluation of instruction.

Waxman & Huang's (1996) review of the literature suggested the notion that the use of technology may change teaching from the traditional teacher-centered model to an approach that is more student-centered. Several conclusions were drawn from their data. (1) The amount of computer technology significantly affected classroom instruction; (2) the finding that the traditional teacher-centered instructional model became a more student-centered instructional approach was similar to the research reported by Swan & Mitrani (as cited in 1993); and (3) the finding that student time on task was increased by computer-based instruction was supported by other researchers (as cited in Worthen, VanDusen & Sailor, 1994; Shofield & Verban, 1988; MacArthur, Haynes & Malouf, 1986). Based on their conclusions, Waxman and Huang recommended study of teacher planning behaviors along with additional study of teacher instructional behavior as affected by technology use although no mention was made of teacher evaluative behavior.

The exceptionally large respondent base for the work of Ravitz, Wong and Becker (1999) allow the survey results of teacher's perceptions of their instructional practice to be seriously considered. More than 4,000 teachers, administrators and technology coordinators involved in school reform were surveyed in 1998. Ravitz, Wong and Becker sought to discover (1) how computer technology use is related to teacher pedagogical beliefs; (2) what constitutes good teaching practice; (3) how teachers go about organizing learning in their classrooms; (4) how teachers design student learning; and (5) how

teacher practice changed over the last three years. The four most common teaching practices identified in this survey were students working individually to answer questions from textbooks or worksheets, teachers leading whole-class discussions, teachers questioning students for the correct answer, and using introductory drills to begin a new unit of study. As the researchers point out, such teacher instructional practices are traditional in nature. However, Ravitz, Wong and Becker also concluded that teachers are more likely to adopt teaching practices associated with a constructivism when their main goals for students changed, when their understanding about how people learn changed; when they experienced staff development associated with constructivism, and when they used computer technology. The changes in teaching practice over the preceding three years described by teachers are more constructivist in nature. More and more, students taught or helped one another, worked in groups, reviewed and revised their own work, and explored a topic on their own or without close teacher direction. Teachers increased the number of activities occurring simultaneously in their classrooms and evaluated student work based on their products rather than tests.

Laptop Computer Technology and Teacher Instructional Behavior

Rockman *ET AL* (1998) reported on the second year of a nationwide laptop computer project, Anywhere, Anytime Learning, co-sponsored by Microsoft Corporation and Toshiba America Information Systems. Fifty-three private and public schools pioneered the laptop program in the fall of 1996. Students in the participating schools acquired and used, on a regular basis, laptop computers loaded with Microsoft Windows and Microsoft Office Professional software. Rockman *ET AL*(1998) tracked the

experiences of students and teachers in four selected pioneer schools through the use of student and teacher survey, shadow studies and interviews, student data collected from simulated problem-solving tasks, and students' detailed description of their favorite projects and activities. It is important to note in this study that these middle and high school students had full access to their laptop computers at school and home, the full access model.

Changes in teaching have occurred in these four pioneer schools. Teachers reported that the Laptop Program encouraged an increase in their reliance on project-based instruction. According to the teachers, they became facilitators providing assistance as needed in more student-centered classrooms rather than directors of learning. Teachers spent less time lecturing and more time working with small groups or individual students. Students collaborated more when using their laptops. They were more actively involved with the subject matter and each other, often interacting with one another as peer teachers.

While broad findings related to implementation of instruction were presented in this study, only Ravitz, Wong and Becker (1999) presented more in depth information concerning what teachers do and why. Waxman and Huang (1996) suggested further study in the area of teacher planning practices. Sheingold and Hadley (1990) and the Oakland County Schools Evaluation Report (1991) shared teacher's feelings about the use of technology and their perception of its impact on their instruction, but findings related to what characterizes teacher evaluation practices were absent. Unfortunately, Rockman *ET AL* did not investigate teacher planning or evaluation practices though there

were broad statements regarding teacher implementation of instruction. Thus, further investigation designed to identify what characterizes teacher instructional behaviors, especially planning and evaluation behaviors, is warranted.

CHAPTER III

METHODS AND PROCEDURES FOR THE STUDY

This chapter provides a detailed explanation of the research methodology for this study and discussion of the data-gathering instrument, the Teacher Questionnaire. Several sections make up this chapter: Research Design, Subjects, Procedure for Data Collection, Variables in the Study, and Procedures for Data Analysis followed by Table 1, and Data Gathering Instrument followed by Table 2.

Research Design

This study used a cross sectional survey design to examine the relationship between student use of laptop computers in one of four models of use: full access, dispersed, class set, and mixed and teacher instructional behaviors, planning, implementation of instruction, and evaluation of instruction. Consistent with a positivist framework, a questionnaire was used to collect the data in a single-stage sampling procedure. Survey design offered several advantages for this study: economy, timeliness, efficiency, and the ability to reach subjects across a vast geographical area.

The purpose of this study was to investigate the relationship between student use of laptop computers in one of four technology models of use: full access, dispersed, class set, and mixed, and teacher instructional behavior. Several research questions arising from this purpose were addressed.

1. What characterizes teacher planning behaviors with regard to time, frequency, complexity, difficulty, need for revision, and use of technological resources and

materials when students use laptop computers in one of four models of use: full access, dispersed, class set, or mixed?

2. Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher planning behaviors with regard to time, frequency, complexity, difficulty, revision, and use of technological resources and materials?
3. What characterizes teacher implementation of instruction with regard to student grouping, instructional strategies, instructional content/subject matter, teacher and student roles, assignments and learning tasks, instructional activities, instructional materials, and student and teacher interactions when students use laptop computers in one of four models of use: full access, dispersed, class set, or mixed?
4. Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to student grouping?
5. Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional strategies?
6. Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional content/subject matter?

7. Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to teacher and student roles?
8. Are there statistically significant differences between the our models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to assignments and learning tasks?
9. Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional activities?
10. : What characterizes teacher evaluation of instruction behaviors with regard to assessment tasks, grading, and homework assessment when students use laptop computers in one of four models of use; full access, dispersed, class set, or mixed?
11. Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to assessment tasks?
12. Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to grading?

13. Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to homework assessment?

Subjects

The subject group was stratified to reflect the four models of use investigated in this study. The subject group was drawn from teachers working in K-12 public and private schools and school districts in the United States whose students used laptop computers. Although most of these K-12 schools and school districts participated in Anytime Anywhere Learning (AAL), teachers working in schools or school districts not participating in AAL were not excluded from the subject group. As explained by Alreck and Settle (1995), an optimal sample size of 300 for large populations is practical and prudent. "For a sample size of 300, there's a 95 percent probability of a range of error less than ten percent of the sample mean." (Alreck & Settle, 1995, p. 62).

The researcher used three sources to identify the subject group to be studied. The first source was the customer list of a major manufacturer of laptop computers secured for this one time only use, and, in a written agreement, the researcher consented not to share or publicize the list. The second source, the AAL website hosted by Microsoft, listed many schools whose students used laptop computers. The third source was a listserv solely devoted to issues related to laptop computer use. A large number of teachers and technology administrators were accessible via this email discussion group hosted by SchoolKit.com.

Procedures for Data Collection

Using the manufacturer's customer list, the researcher contacted the principal or the technology director/coordinator for each school or school district to identify the school's model of use and to enlist participation in this study. Either the principal or technology director/coordinator became the researcher's designated contact person, thereby enabling the researcher to encourage response rate. Three initiatives were taken by the researcher to enhance response rate. (1) Initially, the questionnaires were mailed to the designated contact person in each participating school for distribution to teachers of students who used laptop computers; (2) an email reminder to complete and return the questionnaire was sent after two weeks; and (3) at four weeks, a second email reminder was sent to complete and return the questionnaire. The data collection process spanned a six-week period, at which time the data was considered collected. Procedures for data collection accompanied the Teacher Questionnaires mailed to the researcher's designated contact person for each school participating in the study. A form letter explaining the purpose of this study was attached to each questionnaire for the participants.

These procedures involved minimal cost, permitted responses to be gathered in a cost effective, timely and efficient manner, but most importantly, it allowed the researcher to seek responses from subjects across a vast geographical area with relative ease.

Respondents were asked to provide demographic information and to complete scales designed to measure self-reported information about their instructional behaviors when teaching students who used laptop computers. The final item on the questionnaire

presented respondents the opportunity to offer elaborative information with regard to their instructional behaviors, specifically planning, implementation of instruction, and evaluation of instruction.

Variables in the Study

Many schools nationwide have adopted laptop computers for student use. The independent variables in this study were one of the four models of use employed in these schools and school districts. Planning, implementation of instruction and evaluation of instruction were the dependent variables. Planning was examined with regard to time, frequency, complexity, collegiality, difficulty, need for revision, and use of technological resources and materials. Implementation of instruction was examined with regard to student grouping, instructional strategies, instructional content/subject matter, teacher and student roles, assignments and learning tasks, and instructional activities. The evaluation of instruction component was examined regarding assessment tasks, grading, and assessment of homework.

This study supposed a more constructivist approach to the implementation and evaluation of instruction when students used laptop computers in one of four models of use. More specifically, the study supposed different models of use would have a greater effect on teacher instructional behaviors: (1) planning with regard to frequency, complexity, collegiality, difficulty, need for revision, and use of technological resources and materials, (2) implementation of instruction with regard to student grouping, instructional strategies, instructional content/subject matter, teacher and student roles,

assignments and learning tasks, and instructional activities, and (3) evaluation of instruction with regard to assessments tasks, grading, and homework assessment.

Procedures for Data Analysis

Answers to research question 1, what characterizes teacher planning behaviors with regard to frequency, complexity, collegiality, difficulty, need for revision, and use of technological resources and materials when students use laptop computers in one of four models of use: full access, dispersed, class set, or mixed, was described using descriptive statistics and percentages resulting from the Teacher Questionnaire. Descriptive statistics and percentages were calculated for each item on the Teacher Questionnaire. (See Table 1, Question 1 for a complete list of questionnaire items pertinent to this research question.)

Answers to research question 2, are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher planning behaviors with regard to time, frequency, complexity, collegiality, difficulty, need for revision, and use of technological resources and materials, was sought through the Teacher Questionnaire. (See Table 1, Question 2 for a complete list of questionnaire items pertinent to this research question.) A mean score for each questionnaire item pertaining to teacher planning was calculated. Using these mean scores, analysis of variance enabled the researcher to determine if a significant difference between models of use with regard to teacher planning behaviors existed. Appropriate post hoc statistical test(s) were employed where indicated based upon the results of the analysis of variance.

Answers to research question 3, what characterizes teacher implementation of instruction when students use laptop computers in one of four models of use: full access, dispersed, class set, or mixed, was described using descriptive statistics and percentages resulting from the Teacher Questionnaire. Descriptive statistics and percentages were calculated for each item on the Teacher Questionnaire. (See Table 1, Question 3 for a complete list of questionnaire items pertinent to this research question.)

Answers to research question 4, are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to student grouping, were sought through the Teacher Questionnaire. (See Table 1, Question 4 for a complete list of questionnaire items pertinent to this research question.) A mean score for each questionnaire item pertaining to implementation of instruction with regard to student grouping was calculated. Using these mean scores, analysis of variance enabled the researcher to determine if a significant difference between models of use and implementation of instruction with regard to student grouping existed. Appropriate post hoc statistical test(s) were employed where indicated based upon the results of the analysis of variance.

Answers to research question 5, are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional strategies, were sought through the Teacher Questionnaire. (See Table 1, Question 5 for a complete list of questionnaire items pertinent to this research question.)

A mean score for each questionnaire item pertaining to implementation of instruction with regard to instructional strategies was calculated. Using these mean scores, analysis of variance enabled the researcher to determine if a significant difference between models of use and implementation of instruction with regard to instructional strategies existed. Appropriate post hoc statistical test(s) were employed where indicated based upon the results of the analysis of variance.

Answers to research question 6, are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional content/subject matter, were sought through the Teacher Questionnaire. (See Table 1, Question 6 for a complete list of questionnaire items pertinent to this research question.) A mean score for each questionnaire item pertaining to implementation of instruction with regard to instructional strategies was calculated. Using these mean scores, analysis of variance enabled the researcher to determine if a significant difference between models of use and implementation of instruction with regard to instructional strategies existed. Appropriate post hoc statistical test(s) were employed where indicated based upon the results of the analysis of variance.

Answers to research question 7, are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to teacher and student roles, were sought through the Teacher Questionnaire. (See Table 1, Question 7 for a complete list of questionnaire items pertinent to this research question.)

A mean score for each questionnaire item pertaining to implementation of instruction with regard to instructional strategies was calculated. Using these mean scores, analysis of variance enabled the researcher to determine if a significant difference between models of use and implementation of instruction with regard to instructional strategies existed. Appropriate post hoc statistical test(s) were employed where indicated based upon the results of the analysis of variance.

Answers to research question 8, are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to assignments and learning tasks, were sought through the Teacher Questionnaire. (See Table 1, Question 8 for a complete list of questionnaire items pertinent to this research question.) A mean score for each questionnaire item pertaining to implementation of instruction with regard to instructional strategies was calculated. Using these mean scores, analysis of variance enabled the researcher to determine if a significant difference between models of use and implementation of instruction with regard to instructional strategies existed. Appropriate post hoc statistical test(s) were employed where indicated based upon the results of the analysis of variance.

Answers to research question 9, are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional activities, were sought through the Teacher Questionnaire. (See Table 1, Question 9 for a complete list of questionnaire items pertinent to this research question.)

A mean score for each questionnaire item pertaining to implementation of instruction with regard to instructional strategies was calculated. Using these mean scores, analysis of variance enabled the researcher to determine if a significant difference between models of use and implementation of instruction with regard to instructional strategies existed. Appropriate post hoc statistical test(s) were employed where indicated based upon the results of the analysis of variance.

Answers to research question 10, what characterizes teacher evaluation of instruction behaviors with regard to assessment tasks, grading, and homework assessment when students use laptop computers in one of four models of use; full access, dispersed, class set, or mixed, were described using descriptive statistics and percentages resulting from the Teacher Questionnaire. Descriptive statistics and percentages were calculated for each question on the Teacher Questionnaire. (See Table 1, Question 10 for a complete list of questionnaire items pertinent to this research question.)

Answers to research question 11, are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to assessment tasks, were sought through the Teacher Questionnaire. (See Table 1, Question 11 for a complete list of questionnaire items pertinent to this research question.) A mean score for each questionnaire item pertaining to implementation of instruction with regard to instructional strategies was calculated. Using these mean scores, analysis of variance enabled the researcher to determine if a significant difference between models of use and implementation of instruction with regard to instructional strategies existed. Appropriate

post hoc statistical test(s) were employed where indicated based upon the results of the analysis of variance.

Answers to research question 12, are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to grading, were sought through the Teacher Questionnaire. (See Table 1, Question 12 for a complete list of questionnaire items pertinent to this research question.) A mean score for each questionnaire item pertaining to implementation of instruction with regard to instructional strategies was calculated. Using these mean scores, analysis of variance enabled the researcher to determine if a significant difference between models of use and implementation of instruction with regard to instructional strategies existed. Appropriate post hoc statistical test(s) were employed where indicated based upon the results of the analysis of variance.

Answers to research question 13, are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to homework assessment, were sought through the Teacher Questionnaire. (See Table 1, Question 13 for a complete list of questionnaire items pertinent to this research question.) A mean score for each questionnaire item pertaining to implementation of instruction with regard to instructional strategies was calculated. Using these mean scores, analysis of variance enabled the researcher to determine if a significant difference between models of use and implementation of instruction with regard to instructional strategies existed.

Appropriate post hoc statistical test(s) were employed where indicated based upon the results of the analysis of variance.

A descriptive analysis of all dependent variables in the study was conducted indicating the means, standard deviations and range of scores for these variables. Each item was scored using a Likert Scale ranging from Strongly Disagree to Strongly Agree. Cronbach's Alpha was used to establish the internal reliability measure of these scales.

Table 1

Summary of Procedures for Data Analysis

Research Question 1	
Variable Name	Research Questions
Dependent Variable 1: Planning • Time • Frequency • Complexity • Collegiality • Difficulty • Need for revision • Use of technological resources and materials	Descriptive Research Question 1: What characterizes teacher planning behaviors with regard to time, frequency, complexity, difficulty, need for revision, and use of technological resources and materials when students use laptop computers in one of four models of use: full access, dispersed, class set, and mixed?
Items on Questionnaire	Data Analysis Procedures
See Items: I. Planning Items 1-7	1. Calculate the descriptive statistics and percentages for items 1-7.
Research Question 2	
Variable Name	Research Question
Independent Variables: • Variable 1: Full Access Model • Variable 2: Dispersed Model • Variable 3: Class Set Model • Variable 4: Mixed Model	Inferential Research Question 2: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher planning behaviors with regard to time, frequency, complexity, difficultly, collegiality, need for revision, and use of technological resources and materials?

(table continues)

Items on Questionnaire	Data Analysis Procedures
See Items I. Planning Items 1-7	1. Calculate a mean score for items 1-7. 2. Using the calculated mean score, perform an analysis of variance for items. 3. Perform appropriate post hoc procedures as indicated by the analysis of variance results.

Research Question 3

Variable Name	Research Question
Dependent Variable 2: Implementation of Instruction • Student grouping • Instructional strategies • Instructional content/subject matter • Teacher and student roles • Assignments and learning tasks • Instructional activities	Descriptive Research Question 3: What characterizes teacher implementation of instruction with regard to student grouping, instructional strategies, instructional content/ subject matter, teacher and student roles, assignments and learning tasks, and instructional activities when students use laptop computers in one of four models of use: full access, dispersed, class set, and mixed?

Items on Questionnaire	Data Analysis Procedures
See Items II. Implementation of Instruction Items 10-15	Calculate the descriptive statistics and percentages for items 10-15.

(table continues)

Research Question 4	
Variable Name	Research Question
Independent Variables: • Variable 1: Full Access • Variable 2: Dispersed • Variable 3: Class Set • Variable 4: Mixed	Inferential Research Question 4: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to grouping?
Items on Questionnaire	Data Analysis Procedures
See Items II. Implementation of Instruction Item 10 a	1. Calculate a mean score for item 10 a. 2. Using the calculated mean score, perform an analysis of variance for items. 3. Perform appropriate post hoc procedures as indicated by the analysis of variance results.
Research Question 5	
Variable Name	Research Question
Independent Variables: • Variable 1: Full Access • Variable 2: Dispersed • Variable 3: Class Set • Variable 4: Mixed	Inferential Research Question 5: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional strategies?

(table continues)

Items on Questionnaire	Data Analysis Procedures
See Items II. Implementation of Instruction Items 11 a-k	1. Calculate a mean score for item 11 a-k. 2. Using the calculated mean score, perform an analysis of variance for items. 3. Perform appropriate post hoc procedures as indicated by the analysis of variance results.

Research Question 6

Variable Name	Research Question
Independent Variables: • Variable 1: Full Access • Variable 2: Dispersed • Variable 3: Class Set • Variable 4: Mixed	Inferential Research Question 6: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional content/subject matter?

Items on Questionnaire	Data Analysis Procedures
See Items II. Implementation of Instruction Items 12 a-b	1. Calculate a mean score for item 12 a-b. 2. Using the calculated mean score, perform an analysis of variance for items. 3. Perform appropriate post hoc procedures as indicated by the analysis of variance results.

(table continues)

Research Question 7	
Variable Name	Research Question
Independent Variables: • Variable 1: Full Access • Variable 2: Dispersed • Variable 3: Class Set • Variable 4: Mixed	Inferential Research Question 7: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to teacher and student roles?
Items on Questionnaire	Data Analysis Procedures
See Items II. Implementation of Instruction Items 13 a-d	1. Calculate a mean score for item 13 a-d. 2. Using the calculated mean score, perform an analysis of variance for items. 3. Perform appropriate post hoc procedures as indicated by the analysis of variance results.
Research Question 8	
Variable Name	Research Question
Independent Variables: • Variable 1: Full Access • Variable 2: Dispersed • Variable 3: Class Set • Variable 4: Mixed	Inferential Research Question 8: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to assignments and learning tasks?

(table continues)

Questionnaire	Procedures
See Items II. Implementation of Instruction Items 14 a-b	1. Calculate a mean score for item 14 a-b. 2. Using the calculated mean score, perform an analysis of variance for items. 3. Perform appropriate post hoc procedures as indicated by the analysis of variance results.

Research Question 9

Variable Name	Research Question
Independent Variables: • Variable 1: Full Access • Variable 2: Dispersed • Variable 3: Class Set • Variable 4: Mixed	Inferential Research Question 9: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional activities?

Items on Questionnaire	Data Analysis Procedures
See Items II. Implementation of Instruction Items 15 a-x	1. Calculate a mean score for item 15 a-x. 2. Using the calculated mean score, perform an analysis of variance for items. 3. Perform appropriate post hoc procedures as indicated by the analysis of variance results.

(table continues)

Research Question 10	
Variable Name	Research Question
Dependent Variable 3: Evaluation of Instruction • Assessments tasks • Grading • Homework assessment	Descriptive Research Question 10: What characterizes teacher evaluation of instruction behaviors with regard to assessment tasks, grading, and homework assessment when students use laptop computers in one of four models of use: full access, dispersed, class set, and mixed?
Items on Questionnaire	Data Analysis Procedures
See Items III. Evaluation of Instruction Items 16-18	Calculate the descriptive statistics and percentages for items 16-18.

Research Question 11	
Variable Name	Research Question
Independent Variables: • Variable 1: Full Access • Variable 2: Dispersed • Variable 3: Class Set • Variable 4: Mixed	Inferential Research Question 11: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to assessment tasks?

(table continues)

Items on Questionnaire	Data Analysis Procedures
See Items II. Implementation of Instruction Items 16 a-q	1. Calculate a mean score for item 16 a-q. 2. Using the calculated mean score, perform an analysis of variance for items. 3. Perform appropriate post hoc procedures as indicated by the analysis of variance results.

Research Question 12

Variable Name	Research Question
Independent Variables: • Variable 1: Full Access • Variable 2: Dispersed • Variable 3: Class Set • Variable 4: Mixed	Inferential Research Question 12: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to grading?

Items on Questionnaire	Data Analysis Procedures
See Items II. Implementation of Instruction Items 18 a-k	1. Calculate a mean score for item 18 a-k. 2. Using the calculated mean score, perform an analysis of variance for items. 3. Perform appropriate post hoc procedures as indicated by the analysis of variance results.

(table continues)

Research Question13

Variable Name	Research Question
Independent Variables: • Variable 1: Full Access • Variable 2: Dispersed • Variable 3: Class Set • Variable 4: Mixed	Inferential Research Question Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to homework assessment?
Items on Questionnaire	**Data Analysis Procedures**
See Items II. Implementation of Instruction Items 17 a-l	1. Calculate a mean score for item 17 a-l. 2. Using the calculated mean score, perform an analysis of variance for items. 3. Perform appropriate post hoc procedures as indicated by the analysis of variance results.

Data Gathering Instrument

The teacher questionnaire was constructed from several sources. Literature concerning teacher planning behaviors (Applefield, 1992; Branch, Darwazeh, & El-Hindi, 1992; Callaway, 1988; Clark & Yinger, 1979; Earle, 1996; Littrell, 1982; Northrup & Pilcher, 1998; Walters, 1984; Yinger, 1978), implementation of instruction (Dimock & Boethel, 1999; Heinke, Chen, & Goldman, 1999) and evaluation of instruction (Heinke, Chen, & Goldman, 1999) was reviewed. Five questionnaires were also studied. Two of the questionnaires had been used in nationwide surveys of teachers regarding their instructional practice (Heinke, R.R., Chen, X. & Goldman, G., 1999; Becker, H.J. & Anderson, R.E., 1999) while another was used for a report of four pilot schools whose students use laptop computers (Rockman et al, 1998). Another instrument consulted was the Classroom Observation Schedule (COS), which examined the nature and frequency of student-student and student teacher interactions in a classroom (Waxman, H.C., Huang, S-L.Y & Padron, Y.N. 1997a).

Several steps were taken to establish the face validity of the researcher-designed Teacher Questionnaire. Numerous occasions of professional review guided the development process of the Teacher Questionnaire. After establishing the format and Likert Scale for the questionnaire, various stems and specific items of the questionnaire were developed based upon the suggestions from the professional teacher reviewers that were deemed appropriate by the researcher. On three separate occasions, a total of 15 career teachers with 5 to 21 plus years of teaching experience in both the public and

private sectors reviewed the questionnaire. Suggestions from these three occasions yielded a final draft.

The last step in the development process was a pilot test of the Teacher Questionnaire. Eighteen teachers whose students used laptop computers participated in the pilot test. The pilot test group was predominantly female, 77.8%, and white, 88.8%. Participants ranged in age from 35 to 61 years. The mean age was 49.4 years and the median was 48 years. All of the teachers taught in a private independent parochial school and 44.4% of the teachers held a master degree plus 30 hours. A tri-modal situation occurred with regard to years teaching experience. Equal percentages of pilot test teachers, 27.8%, taught for 6-10 years, 16-20 years, and 21 plus years. Most of the participants, 44.4%, taught students who used laptop computers in a full access model of use for 4-4.5 years. With regard to years of experience, this was a group of veteran career professional teachers who were predominantly white and female. They held advanced degrees plus 30 hours and worked in the full access model of use in a private independent parochial school.

Cronbach's Alpha was performed on the pilot test data to aid the researcher in the development of the questionnaire as well as establish internal reliability measures. Based on the results as seen in Table 2, modifications were made to the Teacher Questionnaire. Measures of internal consistency yielded acceptable levels with the exception of grouping, instructional content, and instructional materials. These scales were revised to produce the final form of the Teacher Questionnaire as seen in Appendix A.

Table 2

Cronbach's Alpha for Pilot Test Data

Scales	N of Items	Alpha
Planning	7	.79
Grouping	2	.27
Instructional Strategies	8	.87
Instructional Content	4	.19
Teacher and Student Roles	4	.86
Assignments and Learning Tasks	7	.70
Instructional Activities	24	.92
Instructional Materials	4	.65
Assessments Tasks	17	.87
Grading	13	.78
Assessing Homework	12	.85

$\underline{p} > .05$

CHAPTER IV

PRESENTATION OF DATA

Introduction

This chapter represents the nature of the data gathered in this study. A cross sectional survey design was used to explore the relationship between student use of laptop computers in one of five models of use: full access, dispersed, class set, scattered, and mixed, and teacher instructional behaviors with respect to planning, implementation of instruction, and evaluation of instruction. Data were collected in a single-stage sampling procedure using the Teacher Questionnaire. Research questions in this study are addressed in the sections of this chapter: General Information about the Subject Group, Description of the Subject Group, Presentation of Survey Results, and Summary of Results.

General Information about the Subject Group

Teacher Questionnaires were mailed to the researcher's contact person at each participating school. The contact person functioned as a liaison to faculty with regard to the questionnaire's dissemination, collection, and return. In preparation for mailing, the researcher determined the number of Teacher Questionnaires required for the faculty and the model of use at each participating school with the assistance of the contact person. In total, 1210 questionnaires were mailed to 74 schools nationwide. The return yielded 363 questionnaires. Of these, four questionnaires were discarded due to an inadequate number within that model of use, and three questionnaires were discarded due to incompleteness.

The remaining 356 completed questionnaires comprised the subject group. The size of each model was N = 89. For a profile description of each model see Appendix B, Table B1.

Description of the Subject Group

The description of the subject group was based upon eight demographic items completed by the 356 respondents. Respondents indicated which of the four models of student laptop use applied to them and the type of school in which they taught. Respondents were also queried about their ages, gender, ethnicity, and highest educational degree held. Data with regard to years of teaching experience as well as the length of time the respondents had taught students who used laptop computers was also collected.

Models of Use: The subject group comprised 356 respondents. Each of the four models of student laptop use: full access, dispersed, class set, and mixed contained 89 respondents. Though an equal number of responses from each of the five models of use were anticipated, the fourth model, "Scattered," produced four completed Teacher Questionnaires. Due to this insufficient number, these questionnaires were not included in the data.

School Type: Teachers taught in three types of K-12 schools, public schools, private independent schools, and private independent parochial schools. Most of the teachers, 50.3%, taught in public schools while 32.3% taught in private independent schools and 17.4% taught in private independent parochial schools.

Age: The mean age of the respondents was 41.0 years with a standard deviation of 9.02 years. Both the mode and median were 40.0 years. More of the teachers in the subject group were between the ages of 24 and 40 years than 42 and 63 years. Forty-four of the respondents or 12.4% of the respondents declined to disclose their age.

Gender: The respondents were predominantly female, but 10 respondents or 2.8% of the subject group declined to disclose their gender. Females accounted for 67.7% of the subjects.

Ethnicity: The subject group was predominantly White, 84.8%. Both the mode and median were White even though five respondents or 1.4% of the subject group declined to disclose their ethnicity. A closer examination of the subject group revealed 4.8% were African American, 5.3% were Asian American, 3.1% were Latino/Hispanic American, and .6% were Other.

Highest Degree Held: All subjects responded to this demographic item and both the median and mode were a master degree, which accounted for 29.5% of the subject group.. Bachelor degrees were held by 12.9% of the subject group, bachelor degrees plus 30 hours were held by 28.4% of the subject group, master degrees plus 30 hours were held by 27.2% of the subject group, and doctorate degrees were held by 1.4% of the subject group. The remaining .6% of the subject group held a Juris Doctor degree.

Years Teaching Experience: Years of experience was categorized in 5-year increments. The mode of the subject group was 0-5 years or 23.0%, although 6 respondents, 1.7% of the subject group, declined to indicate their years of teaching experience. Within the subject group, 19.9% of the teachers had taught for 6-10 years,

20.2% of the teachers had taught for 11-15 years, 15.7% of the teachers had taught for 16-20 years, and 19.4% of the teachers had taught for 21 plus years.

Years Teaching Experience with Laptop Computers: All respondents replied to the query with respect to how many years experience they had teaching students who used laptop computers. For the subject group, the mode was 1-1.5 years experience teaching students who used laptop computers and the median was 2-2.5 years experience.

The subject group was predominantly female and White. Respondents ranged in age from 24 to 63 years, and the median and mode for age was 40 years. Half of the teachers taught in public schools and most teachers held an advanced degree. Furthermore, most of the teachers had taught for 0-5 years and had taught students who used laptop computers for 1-1.5 years. With regard to teaching experience, this was a relatively young group of white female teachers holding advanced degrees and working in public schools.

Presentation of Survey Findings

Research Question 1

Results of the descriptive analysis for research question 1, what characterizes teacher planning behaviors with regard to time spent planning, frequency of planning, complexity of planning, collegiality in planning, difficulty planning, and the need for revision in planning when students use laptop computers in one of four models of use: full access, dispersed, class set, and mixed, as seen in Table 3 indicated on average, respondents “somewhat agreed” on the 5-point Likert Scale. The descriptors of the Likert Scale were 1-Strongly Disagree, 2-Disagree, 3-Somewhat Agree, 4- Agree, and 5-

Strongly Agree. Teachers spent somewhat more time planning when students used laptop computers in one of four models of use. Teachers planned somewhat more frequently and that planning was somewhat more complex when students used laptop computers in one of four models of use. Teachers consulted with their colleagues somewhat more often, and planning was somewhat more difficult when students used laptop computers in one of four models of use. Teachers needed to revise plans somewhat more often when students used laptop computers in one of four models of use. However, the results of the descriptive analysis for use of technological resources and materials indicated on average, respondents "agree" they used technological resources and materials for planning somewhat more often when students used laptop computers in one of four models of use. This result was represented by a mean of 3.0 and standard deviation of 1.0. Although it appeared planning was problematic for teachers, they were more collegial and used technological resources and materials more often for planning.

Table 3

Descriptive Statistics for the Aspects of Planning

Aspects	N	Mean*	Std. Dev.*
Time	356	3.25	1.05
Frequency	356	3.04	1.09
Complexity	356	3.26	1.16

(table continues)

Aspects	N	Mean*	Std. Dev.*
Collegiality	356	3.22	1.25
Difficulty	356	2.63	1.08
Need for revision	356	2.95	1.09
Technological resources and materials	356	4.11	.77

Note. *These are actual values. In the text discussion, these values were rounded to the nearest whole number to reflect the Likert Scale score they represented.

Research Question 2

The results of research question 2, are there statistically significant differences between the four models of use and teacher planning behaviors with regard to time, frequency, complexity, collegiality, difficulty, need for revision, and use of technological resources and materials, are depicted in Table 4. The calculated F ratio with regard to teacher planning behaviors for the four models of use equaled F = 3.747 and exceeded the critical value of F, which was 2.60 for 3 and 352 degrees of freedom; therefore, there were significant differences between the models of use. The probability the observed differences in the means of the models of use would have occurred by chance was less than .05. Because the critical value of F exceeded the .05 alpha level, it was necessary to conduct a post hoc analysis to discern the difference between models. The Dunnett's T3

was chosen because the homogeneity of variance was violated as indicated by the Levene Test. As shown in Table 5, results of the Dunnett's T3 indicated that the full access model differed significantly from the mixed model with regard to teacher planning behaviors. That is, differences between the mean of the full access model, 3.10, and the mean of the mixed model, 3.42, were significantly different. The significance value for the difference between the two models was .014. The Dunnett's T3 analysis also revealed the class set model differed significantly from the mixed model. That is, differences between the mean of the class set model, 3.06 and the mixed model, 3.42, were significantly different. The significance value for the difference between the two models was .006. Although planning was more problematic for teachers working in the mixed model than for teachers working in either the full access or class set models, teachers in the mixed model were more collegial and used technological resources and materials more often than did teachers working in the full access or class set models.

Table 4

Analysis of Variance for Planning

Source	SS	df	M Sq.	F	Sig.
Between groups	7.025	3	2.342	3.747*	.011*
Within groups	220.004	352	.625		
Total	227.030	355			

Note. Sig. presents the actual significance value.

*p < .05

Table 5

Dunnett's T3 Post Hoc Analysis for Planning

Dependent Variable	(I) Model	(J) Model	M Difference (I-J)	Sig.
Planning	Full Access	Mixed	-.3194*	.014
	Class Set	Mixed	-.3563*	.006

Note. Sig. presents the actual significance value.

*p < .05

Research Question 3

The results of the descriptive analysis for research question 3, what characterizes implementation of instruction with regard to grouping, instructional strategies, instructional content, teacher and student roles, assignments and learning tasks, and instructional activities when students use laptop computers in one of four models of use, are depicted in Table 6. Results of the descriptive analysis for instructional strategies indicated on average, respondents "somewhat agreed" on the 5-point Likert Scale. The descriptors of the Likert Scale were 1-Strongly Disagree, 2-Disagree, 3-Somewhat Agree, 4- Agree, and 5-Strongly Agree. Teachers indicated students worked in small groups on projects, assignments, or presentations as a team somewhat more often when students

used laptop computers in one of fours models of use. Teachers emphasized analyzing and interpreting information, organizing, summarizing, and displaying information, guiding/facilitating student learning, and cooperative learning somewhat more often when students used laptop computers in one of four models of use. Additionally, teachers also indicated students worked in small groups on problems for which there are several appropriate answers and for which there are several appropriate methods of solution more often when students used laptop computers in one of four models of use. However, results of the descriptive analysis also indicated respondents "disagreed" they engaged in whole class instruction and direct teaching/lecture more often when students used laptop computers in one of four models of use. These results for instructional strategies were represented by a mean of 3.0 and standard deviation of 1.0.

Results of the descriptive analysis for instructional content as seen in Table 6, indicated on average, respondents "somewhat agreed" on the 5-point Likert Scale. The descriptors of the Likert Scale were 1-Strongly Disagree, 2-Disagree, 3-Somewhat Agree, 4- Agree, and 5-Strongly Agree. Teachers were able to teach a very large number of topics (themes, units, chapters, etc.) somewhat more often when students used laptop computers in one of four models of use. Teachers also indicated they were able to teach a large number of topics (themes, units, chapters, etc.) somewhat more often when students used laptop computers in one of four models of use. These results for instructional content were represented by a mean of 3.0 and standard deviation of 1.0.

Results of the descriptive analysis for teacher and student roles as seen in Table 6, indicated on average, respondents "somewhat agreed" on the 5-point Likert Scale. The

descriptors of the Likert Scale were 1-Strongly Disagree, 2-Disagree, 3-Somewhat Agree, 4- Agree, and 5-Strongly Agree. Results of the descriptive analysis for student learning tasks indicated on average, respondents "somewhat agreed." Students suggested or planned classroom activities somewhat more often when students used laptop computers in one of four models of use. Students worked as independent learners somewhat more often when students used laptop computers in one of four models of use. However, results of the descriptive analysis also indicated on average, respondents "agreed" they learned along with their students more often when students used laptop computers in one of four models of use. These results for teacher and student roles were represented by a mean of 3.0 and standard deviation of 1.0.

Results of the descriptive analysis for student learning tasks as also seen in Table 6, indicated on average, respondents "somewhat agreed" on the 5-point Likert Scale. The descriptors of the Likert Scale were 1-Strongly Disagree, 2-Disagree, 3-Somewhat Agree, 4- Agree, and 5-Strongly Agree. Teachers assigned a task(s) where there was no indisputably correct answer-- where the truth was complex and impossible to know more often when students used laptop computers in one of four models of use. Teachers assigned a task(s) where there were one, possibly two correct answers more often when students used laptop computers in one of four models of use. These results for student learning tasks were represented by a mean of 3.0 and standard deviation of 1.0.

Results of the descriptive analysis for instructional activities as also seen in Table 6, indicated on average, respondents "disagreed, somewhat agreed, and agreed" on the 5-point Likert Scale. The descriptors of the Likert Scale were 1-Strongly Disagree, 2-

Disagree, 3-Somewhat Agree, 4- Agree, and 5-Strongly Agree. On average, respondents "disagreed" students created, updated, or maintained personal websites or created or contributed to the school's and/or class's website more often when students used laptop computers in one of four models of use. Teachers indicated they "disagreed" students used an electronic bulletin board to discuss academic content, issues, and assignments more often when students used laptop computers in one of four models of use. Teachers also indicated they "disagreed" students completed routine exercises or problems from a worksheet, workbook, or text more often when students used laptop computers in one of four models of use. On average, respondents "somewhat agreed" students contributed to their school's and class's publications, ran models electronically, played educational games/simulations electronically, and engaged in virtual field trips more often when students used laptop computers in one of four models of use. Teachers "somewhat agreed" students used email to communicate with experts in a particular field, created, added to, or maintained electronic journals and portfolios, and did photographic art/design electronically more often when students used laptop computers in one of four models of use. Teachers "somewhat agreed" students explained how what they learned in class related to the real world, worked on projects that took one week or more to complete, and applied concepts or principles to different or unfamiliar situations when students used laptop computers in one of four models of use. Teachers "somewhat agreed" students worked on projects, gathered data, conducted an experiment or research project, designed their own problems to solve and related what they are working on to their own experience more often when students used laptop computers in one of four

models of use. Teachers also indicated they "somewhat agreed" students decided on their own procedures for solving a complex problem and then discussed amongst themselves their different procedures and results as well as represented the same idea or relationship more than one way more often when students used laptop computers in one of four models of use. However, teachers indicated they "agreed" students accessed online libraries, databases, reference materials, and newspapers, used email to communicate with other students, and did projects which may/not have included graphic art/design electronically more often when students used laptop computers in one of four models of use. These results for instructional activities were represented by a mean of 3.0 and standard deviation of 1.0. A subject group, teachers indicated they practiced a constructivist approach to the implementation of instruction with regard to grouping, instructional strategies, instructional content, student and teacher roles, assignments and learning tasks, and instructional activities somewhat more often when students used laptop computers in either the full access dispersed, class set, or mixed models of use.

Table 6

Descriptive Statistics for Aspects of Implementation of Instruction

Aspects	N	Mean*	Std. Dev.*
Grouping	356	3.29	1.05
Instructional Strategies	356	2.90	.80
Instructional Content	356	2.68	.95
Teacher and Student Roles	356	3.30	.86
Assignments and Learning Tasks	356	2.80	.94
Instructional Activities	356	2.95	.74

Note. *These are actual values. In the text discussion, these values were rounded to the nearest whole number to reflect the Likert Scale scores they represented.

Research Question 4

The results of research question 4, are statistically significant differences between the models of student laptop use and implementation of instruction with regard to grouping, are depicted in Table 7. The calculated F ratio with regard to grouping for the four models of use equaled F = 4.892 and exceeded the critical value of F, which was 2.60 for 3 and 352 degrees of freedom; therefore, there were significant differences between the models of use. The probability the observed differences in the means of the models of use would have occurred by chance was less than .05. Because the critical

value of F exceeded the .05 alpha level, it was necessary to conduct a post hoc analysis to discern the differences between models. As shown in Table 8, results of the Tukey HSD indicated the full access model differed significantly from the dispersed model with regard to grouping. That is, differences between the mean of the full access model, 3.0, and the mean of the dispersed model, 3.58, were significantly different. The significance value for the difference between the full access and dispersed models was .001. Thus, teachers working in the full access model placed students in small groups to work on projects, assignments, or presentations as a team somewhat more often than teachers working in the dispersed model of laptop implementation.

Table 7

Analysis of Variance for Grouping

Source	SS	df	M Sq.	F	Sig.
Between groups	15.562	3	5.187	4.892*	.002*
Within groups	373.213	352	1.060		
Total	388.775	355			

Note. Sig. presents the actual significance value.

*$p < .05$

Table 8

Tukey HSD Post Hoc Analysis for Grouping

Dependent Variable	(I) Model	(J) Model	M Difference (I-J)	Sig.
Grouping	Full Access	Dispersed	-.5843*	.001*

Note. Sig. presents the actual significance value.

*p < .05

Research Question 5

The results for research question 5, are there statistically significant differences between the models of use and implementation of instruction with regard to instructional strategies, are depicted in Table 9. The calculated F ratio with regard instructional strategies for the four models of use equaled F = 4.952 and exceeded the critical value of F, which was 2.60 for 3 and 352 degrees of freedom; therefore, there were significant differences between the models of use. The probability the observed differences in the means of the models of use would have occurred by chance was less than .05. Because the critical value of F exceeded the .05 alpha level, it was necessary to conduct a post hoc analysis in to discern the difference. Dunnett's T3 was chosen because the homogeneity of variance was violated as indicated by the Levene Test. As shown in Table 10, results of Dunnett's T3 indicated the dispersed model differed significantly from the mixed model with regard to instructional strategies. That is, differences between the mean of the

dispersed model, 2.70, and the mean of the mixed model, 3.12, were significantly different. The significance value for the difference between the dispersed and mixed models was .006. The analysis also revealed the class set model differed significantly from the mixed model with regard to instructional strategies. That is, differences between the mean of the class set model, 2.79, and the mean of the mixed set model, 3.12, were significant. The significance value for the difference between the class set and mixed models was .005. Thus, teachers working in the mixed model are more likely to practice constructivist instructional strategies as depicted on the teacher questionnaire than teachers working in either the dispersed or class set models of laptop implementation.

Table 9

Analysis of Variance for Instructional Strategies

Source	SS	df	M Sq.	F	Sig.
Between groups	9.131	3	3.044	4.952*	.002*
Within groups	216.335	352	.615		
Total	225.466	355			

Note. Sig. presents the actual significance value.

*p < .05

Table 10

Dunnett's T3 Post Hoc Analysis for Instructional Strategies

Dependent Variable	(I) Model	(J) Model	M Difference (I-J)	Sig.
Instructional Strategies	Dispersed	Mixed	-.4143*	.006*
	Class Set	Mixed	-.3216*	.005*

Note. Sig. presents the actual significance value.

*p < .05

Research Question 6

The results for research question 6, are there statistically significant differences between the models of use and implementation of instruction with regard to instructional content, are depicted in Table 11. The calculated F ratio with regard to instructional content for the four models of use equaled F = 13.298 and exceeded the critical value of F, which was 2.60 for 3 and 352 degrees of freedom; therefore, there were significant differences between the models of use. The probability the observed differences in the means of the models of use would have occurred by chance was less than .05. Because the critical value of F exceeded the .05 alpha level, it was necessary to conduct a post hoc analysis in to discern the difference. Dunnett's T3 was chosen because the homogeneity of variance was violated as indicated by the Levene Test. As shown in Table 12, results of Dunnett's T3 indicated that the full access model differed significantly from the

dispersed model with regard to instructional content. That is, differences between the mean of the full access model, 2.77, and the mean of the dispersed model, 2.22, were significantly different. The significance value for the difference was .004 between the two models. The Dunnett's T3 analysis also indicated that the class set model differed significantly from the mixed model with regard to instructional content. That is, differences between the mean of the class set model, 2.64, and the mean of the mixed model, 3.07, were significantly different. The significance value for the difference was .001 between the two models. In addition, the analysis revealed that the class set model differed form the dispersed model with regard to instructional strategies. That is, differences between the mean of the class set model, 2.64, and the mean of the dispersed model, 2.22, were significantly different. The significance value for the difference between the two models was .019. Thus, teachers working in the class set model of laptop implementation were more likely to teach a large number of topics in greater depth than were teachers working in the dispersed model of laptop implementation. However, teachers working in the mixed model of laptop implementation were more likely to teach a large number of topics in greater depth than were teachers working in the class set model of laptop implementation.

Table 11

Analysis of Variance for Instructional Content

Source	SS	df	M Sq.	F	Sig.
Between groups	32.654	3	10.885	13.298*	.000*
Within groups	288.124	352	.819		
Total	320.777	355			

Note. Sig. presents the actual significance value.

*p < .05

Table 12

Dunnett's T3 Post Hoc Analysis for Instructional Content

Dependent Variable	(I) Model	(J) Model	M Difference (I-J)	Sig.
Instructional Content	Class Set	Dispersed	.4157*	.019*
	Class Set	Mixed	-.4270*	.001*

Note. Sig. presents the actual significance value.

*p < .05

Research Question 7

The results for research question 7, are there statistically significant differences between the models of use and implementation of instruction with regard to teacher and student roles, are depicted in Table 13. The calculated F ratio with regard to teacher and student roles for the four models of use equaled F = 5.934 and exceeded the critical value of F, which was 2.60 for 3 and 352 degrees of freedom; therefore, there were significant differences between the models of use. The probability that the observed differences in the means of the models of use would have occurred by chance was less than .05. Because the critical value of F exceeded the .05 alpha level, it was necessary to conduct a post hoc analysis in to discern the difference. Dunnett's T3 was chosen because the homogeneity of variance was violated as indicated by the Levene Test. As shown in Table 14, results of Dunnett's T3 indicated that the full access model differed significantly from the dispersed model with regard to teacher and student roles. That is, differences between the mean of the full access model, 3.41, and the mean of the dispersed model, 3.02, were significantly different The significance value for the difference was .027 between the two models. Dunnett's T3 analysis also indicated that the dispersed model differed significantly from the mixed model with regard to teacher and student roles. That is, differences between the mean of the dispersed model, 3.02, and the mean of the mixed model, 3.52, were significant. The significance value for the difference between the two models was .001. Thus, teachers working in the full access and mixed models of laptop implementation were more likely to employ and experience

teacher and student roles as depicted on the teacher questionnaire than teachers working in the dispersed model.

Table 13

Analysis of Variance for Teacher and Student Roles

Source	SS	df	M Sq.	F	Sig.
Between groups	12.670	3	4.223	5.934*	.001*
Within groups	250.518	352	.712		
Total	263.188	355			

Note. Sig. presents the actual significance value.

*p < .05

Table 14

Dunnett's T3 Post Hoc Analysis for Teacher and Student Roles

Dependent Variable	(I) Model	(J) Model	M Difference (I-J)	Sig.
Teacher and Student Roles	Full Access	Dispersed	.3904*	.027*
	Dispersed	Mixed	-.5000*	.001*

Note. Sig. presents the actual significance value.

*p < .05

Research Question 8

The results for research question 8, are there statistically significant differences between the models of use and implementation of instruction with regard to assignments and learning tasks, are depicted in Table 15. The calculated F ratio with regard to assignments and learning tasks for the four models of use equaled F = 2.171 and did not exceed the critical value of F, which was 2.60 for 3 and 352 degrees of freedom; therefore there were no significant differences between the models of use. Thus, there were no differential effects between models of laptop implementation with regard to assignments and learning tasks.

Table 15

Analysis of Variance for Assignments and Learning Tasks

Source	SS	df	M Sq.	F	Sig.
Between groups	5.646	3	1.882	2.171	.091
Within groups	305.090	352	.867		
Total	310.736	355			

Note. Sig. presents the actual significance value.

*p < .05

Research Question 9

The results of research question 9, are there statistically significant differences between the models of use and implementation of instruction with regard to instructional activities, are depicted in Table 16. The calculated F ratio with regard to instructional activities for the four models of use equaled F = 11.247 and exceeded the critical value of F, which was 2.60 for 3 and 352 degrees of freedom; therefore there were significant differences between the models of use. The probability that the observed differences in the means of the models of use would have occurred by chance was less than .05. Because the critical value of F exceeded the .05 alpha level, it was necessary to conduct a post hoc analysis in to discern the difference. Dunnett's T3 was chosen because the homogeneity of variance was violated as indicated by the Levene Test. As shown in Table 17, results of Dunnett's T3 indicated that the full access model differed significantly from the dispersed model with regard to instructional activities. That is, differences between the mean of the full access model, 3.15, and the mean of the dispersed model, 2.67, were significant. The significance value for the difference was .000 between the two models. Dunnett's T3 analysis also indicated that the dispersed model differed significantly from the mixed model with regard to instructional activities. That is, differences between the mean of the dispersed model, 2.67, and the mean of the mixed model, 3.18, were significant. The significance value for the difference between the two models was .011. Moreover, the analysis revealed that the class set model differed significantly from the mixed model with regard to instructional activities. That is, differences between the mean of the class set models, 2.81, and the mean of the mixed

model, 3.18, were significant. The significance value for the difference between the class set and mixed models was .003. Thus, teachers working in the full access and mixed models of laptop implementation were more likely to practice a constructivist approach with regard to instructional strategies than teacher working in the either the dispersed or class set models of laptop implementation.

Table 16

Analysis of Variance for Instructional Activities

Source	SS	df	M Sq.	F	Sig.
Between groups	16.803	3	5.601	11.247*	.000*
Within groups	175.300	352	.498		
Total	263.188	355			

Note. Sig. presents the actual significance value.

*$p < .05$

Table 17

Dunnett's T3 Post Hoc Analysis for Instructional Activities

Dependent Variable	(I) Model	(J) Model	M Difference (I-J)	Sig.
Instructional Activities	Full Access	Dispersed	.4738*	.000*
	Full Access	Class Set	.3315*	.011*
	Dispersed	Mixed	-.5122*	.000*
	Class Set	Mixed	-.3699*	.003*

Note. Sig. presents the actual significance value.

*p < .05

Research Question 10

The results for research question 10, what characterizes the evaluation of instruction with regard to assessment tasks, grading, and assessing homework when students use laptop computer in one of the models of use, are depicted in Table 18. Results of the descriptive analysis for kind of assessment tasks teachers utilized, indicated on average, respondents "somewhat agreed" on the 5-point Likert Scale. The descriptors of the Likert Scale were 1-Strongly Disagree, 2-Disagree, 3-Somewhat Agree, 4- Agree, and 5-Strongly Agree. Respondents indicated students not only evaluated and improved their own work, but also evaluated and improved their work because of peer feed back as well as conferred with other students about their work somewhat more often

when students used laptop computers in one of four models of use. Respondents "somewhat agreed" students wrote essays or held serious discussion assessing their work, how it could be improved, etc., and wrote an essay or paper in which they were expected to explain their thinking somewhat more often when students used laptop computers in one of four models of use. Respondents "somewhat agreed" students presented as part of a group on projects or presentations to earn a group and individual grade as well as presented oral reports to the whole class as individuals somewhat more often when students used laptop computers in one of four models of use. Respondents "somewhat agreed" students discussed with the whole class solutions developed in small groups, made a product that would be used by someone else, and demonstrated their work to audience including people other than from school or their family somewhat more often when students used laptop computer in one of four models of use. Respondents also "somewhat agreed" students responded orally to teacher generated open-ended questions, explained how what they learned in class related to the real world, and put things in order and explained why they were organized in that way somewhat more often when students used laptop computer in one of four models of use. However, results of the descriptive analysis also indicated on average, respondents "disagreed" students took a test or quiz for a full period or more than a full period more often when students used laptop computer in one of four models of use.

Results of the descriptive analysis for what teachers did when assessing homework activities indicated on average, respondents "somewhat agreed" on the 5-point Likert Scale. The descriptors of the Likert Scale were 1-Strongly Disagree, 2-Disagree, 3-

Somewhat Agree, 4- Agree, and 5-Strongly Agree. Respondents "somewhat agreed" they checked to see if students had done the homework, kept homework in a student portfolio, used homework to elicit students' ideas and opinions, and used assignments as a basis for class discussions, grading students and lesson planning somewhat more often when students used laptop computers in one of four models of use. However, respondents "disagreed" they used homework to see if students knew the correct answer more often when students used laptop computers in one of four models of use. Respondents also "disagreed" they recorded only whether the assignment was completed more often when students used laptop computers in one of four models of use. Respondents also "disagreed" they collected, corrected, and kept assignments or collected, corrected and returned assignments more often when students used laptop computers in one of four models of use. Additionally, respondents "disagreed" students exchanged and corrected homework assignments in class or students corrected their own homework assignments in class more often when students used laptop computers in one of four models of use. These results were represented by a mean of 3.0 and standard deviation of 1.0.

Using the 5-point Likert Scale, results of the descriptive analysis for how teachers graded, indicated on average, respondents "somewhat agreed." The descriptors of the Likert Scale were 1-Strongly Disagree, 2-Disagree, 3-Somewhat Agree, 4- Agree, and 5-Strongly Agree. Respondents indicated they gave somewhat more importance to effort, individual improvement, achievement relative to the rest of the class, class participation, regular completion of homework, and consistent attendance when grading students who used laptop computers in one of four models of use. Respondents also indicated they

gave somewhat more importance to results of tests that included open-ended as well as multiple–choice and true false items, performance on projects or practical exercises, and their own observations when grading students who used laptop computers in one of four models of use. However, respondents also indicated disagreement with the statement they gave more importance to student absolute level of achievement when grading students who used laptop computers in one of four models of use.

Table 18

Descriptive Statistics for Aspects of Evaluation of Instruction

Aspects	N	Mean*	Std. Dev.*
Assessment Activities	356	2.83	.71
Grading	356	2.96	.79
Homework Assessment	356	2.50	.74

Note. *These are actual values. In the text discussion, these were rounded to the nearest whole number to reflect the Likert Scale scores they represented.

Research Question 11

The results for research question 11, are there statistically significant differences between the models of use and evaluation of instruction with regard to assessment tasks, are depicted in Table 19. The calculated F ratio with regard to assessment tasks for the four models of use equaled F = 7.723 and exceeded the critical value of F, which was

2.60 for 3 and 352 degrees of freedom; therefore, there were significant differences between the models of use. The probability that the observed differences in the means of the models of use would have occurred by chance was less than .05. Because the critical value of F exceeded the .05 alpha level, it was necessary to conduct a post hoc analysis in to discern the difference. Dunnett's T3 was chosen for this analysis because as indicated by the Levene Test, the homogeneity of variance was violated. As shown in Table 20, results of Dunnett's T3 indicated that the full access model differed significantly from the dispersed model with regard to assessment tasks. That is, differences between the mean of the full access model, 2.96, and the mean of the dispersed model, 2.55, were significantly different. The significance value for the difference between the two models was .004. Additionally, results of Dunnett's T3 indicated the dispersed model differed significantly from the mixed model with regard to assessment tasks. That is, differences between the mean of the dispersed model, 2.55, and the mean of the mixed model, 3.0, were significantly different. The significance value for the difference between the dispersed and mixed models was .000. Thus, teachers working in the full access and mixed models of laptop implementation were more likely to assign assessment tasks which were constructivist in nature as depicted on the teacher questionnaire than teachers working in the dispersed model of laptop implementation.

Table 19

Analysis of Variance for Assessment Activities

Source	SS	df	M Sq.	F	Sig.
Between groups	11.114	3	3.705	7.723*	.000*
Within groups	168.853	352	.480		
Total	179.967	355			

Note. Sig. presents the actual significance value.

*p < .05

Table 20

Dunnett's T3 Post Hoc Analysis for Assessment Activities

Dependent Variable	(I) Model	(J) Model	M Difference (I-J)	Sig.
Assessment Activities	Full Access	Dispersed	.4118*	.004*
	Dispersed	Mixed	-.4481*	.000*

Note. Sig. presents the actual significance value.

*p < .05

Research Question 12

The results for research question 12, are there statistically significant differences between the models of use and evaluation of instruction with regard to grading, are depicted in Table 21. The calculated F ratio with regard to grading for the four models of use equaled F = 9.597 and exceeded the critical value of F, which was 2.60 for 3 and 352 degrees of freedom; therefore there were significant differences between the models of use. The probability that the observed differences in the means of the models of use would have occurred by chance was less than .05. Because the critical value of F exceeded the .05 alpha level, it was necessary to conduct a post hoc analysis in to discern the difference. Dunnett's T3 was chosen because the homogeneity of variance was violated as indicated by the Levene Test. As shown in Table 22, results of Dunnett's T3 indicated the mixed model differed significantly from the other three models with regard to grading. The mixed model differed significantly from the full access model. That is, differences between the mean of the mixed model, 3.29, and the mean of the full access model, 3.00, were significantly different. The significance value for the difference was .027 between the mixed model and the full access model. The mixed model differed significantly from the dispersed model. That is, differences between the mean of the mixed model, 3.29, and the mean of dispersed model, 2.82, were significantly different. The significance value for the difference between the mixed model and the dispersed model was .000. Lastly, the mixed model differed significantly from the class set model. That is, the differences between the mean of mixed model, 3.29, and the mean of the class set model, 2.72, were significantly different. The significance value for the

difference between the mixed model and the class set model was .000. Thus, teachers working in the mixed model were more likely to give importance to grading factors as depicted on the teacher questionnaire than teachers working all other models of laptop implementation.

Table 21

Analysis of Variance for Grading

Source	SS	df	M Sq.	F	Sig.
Between groups	17.016	3	5.672	9.835*	.000*
Within groups	203.008	352	.577		
Total	220.024	355			

Note. Sig. presents the actual significance value.

*p < .05

Table 22

Dunnett's T3 Post Hoc Analysis for Grading

Dependent Variable	(I) Model	(J) Model	M Difference (I-J)	Sig.
Grading	Mixed	Full Access	.2850*	.027*

(table continues)

Dependent Variable	(I) Model	(J) Model	M Difference (I-J)	Sig.
Mixed	Dispersed	.4668*	.000*	
	Mixed	Class Set	.5781*	.000*

Note. Sig. presents the actual significance value.

*p < .05

Research Question 13

The results of research question 13, are there statistically significant differences between the models of use and evaluation of instruction with regard to homework., are depicted in Table 23. The calculated F ratio with regard to homework for the four models of use equaled F = 5.308 and exceeded the critical value of F, which was 2.60 for 3 and 352 degrees of freedom; therefore, there were significant differences between the models of use. The probability that the observed differences in the means of the models of use would have occurred by chance was less than .05. Because the critical value of F exceeded the .05 alpha level, it was necessary to conduct a post hoc analysis in to discern the difference. As shown in Table 24, results of the Tukey HSD indicated that the mixed model differed significantly from the dispersed model with regard to homework. That is, differences between the mean of the mixed model, 2.63, and the mean of the dispersed model, 2.27, were significantly different. The significance value for the difference was .006 between the mixed model and the dispersed model. The analysis additionally

revealed that the full access model differed significantly from the dispersed model. That is, the differences between the mean of the full access model, 2.65, and the mean of the dispersed model, 2.27, were significantly different. The significance value vor the difference between the two models was .003. Thus, teachers working in the full access and mixed models of laptop implementation were more likely to assess homework as depicted on the teacher questionnaire than were teachers working in the dispersed model of laptop implementation.

Table 23

Analysis of Variance for Homework Assessment

Source	SS	df	M Sq.	F	Sig.
Between groups	8.443	3	2.814	5.308*	.001*
Within groups	186.629	352	.530		
Total	195.071	355			

Note. Sig. presents the actual significance value.

*$p < .05$

Table 24

Tukey HSD Post Hoc Analysis for Homework Assessment

Dependent Variable	(I) Model	(J) Model	M Difference (I-J)	Sig.
Homework Assessment	Full Access	Dispersed	.3799*	.003*
	Dispersed	Mixed	-.3555*	.006*

Note. Sig. presents the actual significance value.

*p < .05

Summary of Survey Results

Answers to the research questions posed in this study revealed several significant differences in teacher instructional practices now that students used laptop computers in one of four models of use: full access, dispersed, class set, and mixed. As revealed by the post hoc tests, significant differences occurred between models with regard to planning, grouping, instructional strategies, instructional content/subject matter, teacher and student roles, instructional activities, student assessment activities, homework assessment, and grading. There were no significant differences associated with the four models of student laptop computer use and assignments and learning tasks.

Planning

More specifically, the findings for planning suggested differences between two sets of models as seen in Table 4. The mean difference evidenced between the full access

and mixed models was -.3194 indicating that teachers whose students now used laptop computers in a mixed model were more likely to respond, "agree." These teachers perceived themselves as spending more time planning and planning more frequently. Their responses also suggested planning was more complex and collegial, but more difficult. They needed to revise plans more frequently and used technologically resources and materials more often than teachers whose students use laptop computers in the full access model. The mean difference of -.3563 indicated this finding held true for teachers whose students use computers in the class set and mixed models as well. It appeared the planning behaviors as queried on the questionnaire were more problematic for teachers working in a mixed model of laptop computer implementation.

Student Grouping

Post hoc analysis of the results of implementation of instruction revealed significance in several areas of classroom teacher practice: student grouping for instruction, instructional strategies, instructional content/subject matter, teacher and student roles concerning instruction, and instructional activities employed in the classroom. As shown in Table 8, a significant difference was demonstrated between two models with regard to grouping. The mean difference between the full access and dispersed models was -.5843. On the 5-point Likert Scale, teachers working in a mixed model of use appeared more likely to "agree" they have students work in small groups on projects, assignments, or presentations more often than teachers working in the full access model of use do. The dispersed model affected implementation of instruction with regard to grouping. In the dispersed model, students may or may not use laptop

computers. Therefore, teachers were more likely to group students around students with laptop computers in order to maximize the advantages of technology in the classroom.

Instructional Strategies

There were significant differences involving the mixed model of student use of laptop computers with regard to instructional strategies as shown in Table 10. The mean difference between the dispersed model and mixed model was -.4143, and -.3216 mean difference between the class set and mixed models. The negative mean difference indicated the teachers in the mixed model of both comparisons of the means were more likely to "agree" with the instructional strategy items on the questionnaire. They appear to be practicing the instructional strategies that were more constructivist in nature more often when students used laptop computers.

Instructional Content/Subject Matter

The data analysis confirmed 3 sets of models demonstrated a significant difference between means with regard to instructional content/subject matter as shown in Table 12. Teachers were queried about the number of topics they taught and depth in which the topics were covered. The mean difference between the full access and dispersed models was .5449 indicating teachers working in the full access model perceived they taught a large number of topics as well as cover them in greater depth when students used laptop computers. This held true for the mean comparison between the class set and dispersed models as specified by a mean difference of .4157. However, the mean difference between the class set and mixed models was -.4270. Teachers

working in the mixed model perceived they taught more topics in greater depth than teachers working in the class set model when students used laptop computers.

Teacher and Student Roles

Results of the post hoc data analysis for teacher and student roles as shown in Table 14 indicated the full access and dispersed models were significantly different as were the dispersed and mixed models. The mean difference evidenced between the full access model and dispersed model for teacher and student roles was .3904. Thus, it appeared teachers in the full access model were more likely to perceive a difference in their practice affecting teacher and student roles than teachers in the dispersed model. Teachers working in the mixed model were also more likely to perceive the same difference in their instructional practice with regard to teacher and student roles as compared to teachers working in the dispersed model. This was indicated by a mean difference of -.5000 between the dispersed and mixed models.

Assignments and Learning Tasks

As shown in Table 15, there were no significance differences between models of use and assignments and learning tasks. Student use of a laptop computer in any model did not impact assignments and learning tasks.

Instructional Activities

Instructional strategies utilized by teachers in the classroom were the last aspect of implementation of instruction investigated in this study. As evidenced by the results of the post hoc analysis seen in Table 17, four sets of models demonstrated significant differences between means. These were the full access and dispersed models, full access

and class set models, the dispersed and mixed models, and the class set and mixed models. Mean differences involving the full access model indicated in each case teachers were more likely to perceive differences with regard to instructional strategies as queried on the questionnaire when students used laptop computers than either the dispersed or class set models. This was indicated by a mean difference of .4738 between the full access and dispersed models, and a mean difference of .3315 between the full access and class set models. When compared to teachers in the dispersed model, teachers in the mixed model were more likely to indicate they perceived differences with regard to their instructional activities when students used laptop computers as evidenced by a mean difference of -.5122 between the two models. This comparison held true for the class set and mixed models as well, but to a slightly lesser degree as demonstrated by a mean difference of -.3699.

Assessment Activities

Assessment activities, assessing homework activities, and grading were the aspects of evaluation of instruction investigated in this study. As shown in Table 20, the results of the post hoc analysis for assessment activities revealed a mean difference of .4118 between the full access and dispersed models indicating teachers working in the full access model were more likely to perceive differences with regard to assessment tasks as presented on the questionnaire than teachers working in the dispersed model. However, teachers in the mixed model were more likely to perceive differences with regard to assessments tasks presented on the questionnaire than teachers working in the dispersed model as indicated by a mean of -.4481 between the two models.

Grading

Post analysis of evaluation of instruction with regard to teacher grading revealed significant differences between three sets of models as shown in Table 22. These were the mixed and full access models, the mixed and dispersed models, and the mixed and class set models. In all cases, teachers in the mixed model were more likely to perceive differences regarding their grading when they taught students who used laptop computers than teachers in the full access, the dispersed or class set models. This finding was evidenced by the mean differences between the three sets of models. The mean difference between the mixed and full access models was .2850, between the mixed and dispersed models, .4668, and between the mixed and class set models, .5781.

Assessing Homework Activities

Results of the post hoc data analysis for assessing homework activities, as shown in Table 24, indicated the full access and dispersed models were significantly different as were the dispersed and mixed models. The mean difference evidenced between the full access model and dispersed model for teacher and student roles was .3799. Thus, it teachers in the full access model perceived they were more likely to give importance to factors such as effort, individual improvement, class participation, etc. than teachers in the dispersed model. However, teachers in the dispersed model perceived they were more likely to give importance to these grading factors than teachers working in the mixed model as indicated by a mean difference of -.3555.

The full access model affected teacher instructional behaviors with regard to student and teacher roles, instructional activities, assessment tasks, and assessing

homework. It may be each of these dependent variables was influenced by the homogeneity of student laptop use inherent in the full access model. Regardless, teachers were able to practice a constructivist approach to implementation of instruction more easily in the most technology rich model of laptop implementation. Integrating the use of technology into classroom practice was relatively easy when the advantages of technology were at the fingertips of both teachers and students.

The class set model of laptop computer implementation had no effect on teacher instructional behaviors with regard to planning, grouping, instructional strategies, student and teacher roles, assessment tasks, and assessing homework tasks. In the class set model, teachers check out class sets of laptop computers for a period of time. As a result, student use is sporadic in this model as opposed to constant in the full access model; thus, the impact of student laptop use is minimal on the implementation of instruction with regard to these dependent variables.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

This chapter presents a broad summary of this research study. With the exception of Conclusions and Recommendations for Further Study, the sections in this chapter are presented in a summarized form: Purpose of the Study, Research Questions, Subjects, Research Design, Instrumentation, Procedures, Research Questions and Summary of Findings, Conclusions, and Recommendations for Further Study.

Purpose of the Study

The purpose of this study was to investigate the relationship between the models of student laptop computer use and constructivist teacher instructional behaviors.

Research Questions

Research Question 1-13 and the Summary of findings are presented beginning on page 92.

Subjects

The subject group was predominantly female and White. Respondents ranged in age from 24 to 63 years, and the median and mode for age was 40 years. Half of the teachers taught in public schools and most teachers held an advanced degree. Furthermore, most of the teachers in the sample taught for 0-5 years and most of the teachers in the sample taught students who used laptop computers for 1-1.5 years. With

regard to teaching experience, this was a relatively young group of white female teachers holding advanced degrees and working in public schools.

The 356 subjects who participated in this study were drawn from the population of teachers working in K-12 public and private schools in the United States whose students used laptop computers in one of four models of use: full access, dispersed, class set, and mixed. Laptop computers were equipped with the Window operating system. The customer list from a major manufacturer of laptop computers was secured in order to identify the population to be studied. The list was given with the stipulation it was to be used one time, for this study, and not to be shared or publicized. Additionally, many schools were identified through the discussion group for teachers and administrators who work with students using laptop computers hosted by SchoolKit.com.

Research Design

This study used a cross sectional survey design to examine the relationship between student use of laptop computers in one of four models of use: full access, dispersed, class set, and mixed, and teacher instructional behaviors, planning, implementation of instruction, and evaluation of instruction. Consistent with a positivist framework, a questionnaire was used to collect the data in a single-stage sampling procedure.

Instrumentation

The teacher questionnaire was a researcher-designed instrument. Several questionnaires concerned with teacher planning, implementation of instruction or evaluation of instruction as well as an observation scale for teacher interactions were

reviewed. The process of development for the teacher questionnaire involved several occasions of professional review by career teachers with 5-21+ years of teaching experience to establish the face validity of the questionnaire. Additionally, Cronbach's Alpha was used to establish the internal reliability of the instrument in a pilot test of the questionnaire. As seen in Appendix A, the Teacher Questionnaire asked teachers to compare their instructional behaviors now that they taught student who used laptop computers to their instructional behaviors when students did not have access to laptop computers. Furthermore, teachers used a 5-point Likert Scale to respond to this self-reported comparative query. The descriptors for this Likert Scale were: 1-Strongly Disagree, 2-Disagree, 3-Somewhat Agree, 4-Agree, and 5-Strongly Agree.

Procedures

Using the manufacturer's customer list, AAL website, and the SchoolKit.com discussion group, the researcher engaged in a two-step procedure to identify schools willing to participate in this study. The principal or technology director in the schools was contacted to identify the model of student laptop computer use in that school, to establish their willingness to participate in this study, and to identify a contact person. The contact person in each participating school served as the researcher's liaison with the teachers in that school. The role of the contact person was to communicate with the researcher regarding receipt, dissemination, and return of the questionnaires as well as to encourage teachers to complete the questionnaire. In total, 1210 questionnaires were mailed to 74 schools nationwide. The return yielded 363 questionnaires. Of these, four questionnaires were discarded due to an inadequate number within that model of use, and

three questionnaires were discarded due to incompleteness. The remaining 356 completed questionnaires comprised the subject group. Data collection was completed within six-weeks of mailing the questionnaires to the contact person for each participating school.

The data was analyzed using descriptive statistics and analysis of variance with appropriate post hoc tests, Dunnett's T3 and the Tukey HSD. Descriptive statistics were used to describe the subject group regarding the demographic data as well as characterize planning with regard to time, frequency, complexity, collegiality, difficult, need for revision, and use of technological resources and materials, implementation of instruction with regard to grouping, instructional strategies, instructional content, teacher and student roles, assignments and learning tasks, and instructional activities, as well as evaluation of instruction with regard to assessment tasks, grading and assessing homework. The analysis of variance was performed to determine if statistically significant differences existed between models of student laptop use for planning with regard to time, frequency, complexity, collegiality, difficulty, need for revision, and use of technological resources and materials, implementation of instruction with regard to grouping, instructional strategies, instructional content, teacher and student roles, assignments and learning tasks, and instructional activities, as well as evaluation of instruction with regard to assessment tasks, grading, and assessing homework. Where a statistically significant difference was indicated by the analysis of variance, either the Dunnett's T3 or Tukey HSD was used to further analyze the data.

Research Questions and Summary of Findings

Answers to the research questions posed in this study revealed several statistically significant differences in teacher instructional practices now that students used laptop computers in one of four models of use: full access, dispersed, class set, and mixed. As post hoc statistical procedures revealed, significant differences occurred between the models of use and teacher instructional behaviors with regard to planning, grouping, instructional strategies, instructional content/subject matter, teacher and student roles, instructional activities, student assessment tasks, homework assessment, and grading. There were no significant differences associated with the four models of student laptop computer use and implementation of instruction with regard to assignments and learning tasks.

Research question 1: What characterizes teacher planning behaviors with regard to time, frequency, complexity, difficulty, need for revision, and use of technological resources and materials when students use laptop computers in one of four models of use: full access, dispersed, class set, or mixed? As a subject group, teachers found planning to be more demanding. Teachers perceived themselves spending more time planning and planning more frequently. Teachers needed to revise plans more frequently, but used technological resources and materials more often. Teacher responses also revealed planning was more complex and collegial, but more difficult.

Research question 2: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher planning behaviors with regard to time, frequency, complexity,

difficulty, revision, and use of technological resources and materials? Post hoc data analysis revealed a statistically significant difference between the mixed and class set models as well as the mixed and full access models. Now that students used laptop computers, teachers working in the mixed model found planning to be more arduous with regard to time spent planning, the frequency of planning, complexity of planning, difficulty of planning, and the need for more frequent revision of plans than teachers in the full access or class set models. However, teachers in the mixed models also regarded themselves as more collegial in their planning and perceived themselves using technological resources and materials more often now that students used laptop computers.

Research question 3: What characterizes teacher implementation of instruction with regard to student grouping, instructional strategies, instructional content/subject matter, teacher and student roles, assignments and learning tasks, and instructional activities when students use laptop computers in one of four models of use: full access, dispersed, class set, or mixed? Teachers placed students in small groups on projects, assignments, or presentations as a team more often now that students used laptop computers. Teachers indicated they practiced constructivist instructional strategies somewhat more often and were able to present topics covered in greater depth somewhat more often now that students used laptop computers. Moreover, student and teacher roles were somewhat more constructivist in nature, as queried on the teacher questionnaire, more often now that students used laptop computers. Teachers reported they implemented

constructivist assignments and learning tasks and practiced constructivist instructional activities somewhat more often now that students used laptop computers.

Research question 4: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to student grouping? Teachers working in a mixed model of use were more likely to have students work in small groups on projects, assignments, or presentations more often than teachers working in the full access model of use now that students used laptop computers.

Research question 5: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional strategies? Teachers in the mixed model of use practiced instructional strategies that were more constructivist in nature more often than teachers in the dispersed or class set models of use now that students used laptop computers.

Research question 6: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional content/subject matter? Teachers working in the full access model perceived they taught topics in greater depth than teachers in the dispersed model now that students used laptop computers. Teachers working in the dispersed and mixed models of use taught topics in greater depth more often than teachers working in the class set model of use now that students used laptop computers.

Research question 7: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to teacher and student roles? The full access and dispersed models were significantly different as were the dispersed and mixed models. Teachers working in the full access and mixed models of use perceived themselves as learning along with students more often, and perceived students as carrying more responsibility for their learning more often than teachers working in the dispersed model of use now that students used laptop computers. Teachers in the full access and mixed models of use also allowed students to suggest or plan classroom activities, and work as independent learners more often than teachers in the dispersed model of use now that students used laptop computers.

Research question 8: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use of laptop computers and teacher implementation of instruction with regard to assignments and learning tasks? There were no statistically significance differences between models of use and assignments and learning tasks. This was a weak item n the questionnaire. If the item had been richer and had included more items, it may have yielded a significant finding. This area of instruction, assignments and learning tasks, should continue to be investigated.

Research question 9: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher implementation of instruction with regard to instructional

activities? Four sets of models demonstrated significant differences between means. These were the full access and dispersed models, full access and class set models, the mixed and dispersed models, and the mixed and class set models. When compared to teachers in the full access model, teachers in the dispersed and class set models were more likely to indicate they perceived differences with regard to their instructional activities now that students used laptop computers. For example, in the full access model, teachers were more likely to put students at the center of learning and use critical thinking skills activities as evidenced by instructional activities that required students to decide on their own procedures for solving a complex problem and then discuss amongst themselves different procedures and results, or relate what they were working on to their own experiences. This comparison held true for the mixed model compared to the dispersed and class set models as well. This study confirmed similar findings in the third year report of the Rockman ET AL group (2000).

Research question 10: What characterizes teacher evaluation of instruction behaviors with regard to assessment tasks, grading, and homework assessment when students use laptop computers in one of four models of use; full access, dispersed, class set, or mixed? Teachers revealed they gave somewhat more importance to grading as queried on teacher questionnaire now that students used laptop computers. Teachers indicated they implemented homework assessment that was somewhat more constructivist in nature now that students used laptop computers.

Research question 11: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop

computers and teacher evaluation of instruction with regard to assessment tasks? Teachers working in the full access model were more likely to perceive differences with regard to assessment tasks as presented on the questionnaire than teachers working in the dispersed model now that students used laptop computers. Additionally, teachers in the mixed model were more likely to perceive differences with regard to assessments tasks presented on the questionnaire than teachers working in the dispersed model now that students used laptop computers.

Research question 12: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to grading? Post hoc procedures revealed significant differences between three sets of models. These were the mixed and full access models, the mixed and dispersed models, and the mixed and class set models. In all cases, teachers in the mixed model were more likely to perceive differences regarding their grading now that students used laptop computers than teachers in the full access, dispersed, or class set models. Teachers in the mixed model perceived they were more likely to give importance to factors such as effort, individual improvement, class participation, etc. than teachers in the full access, dispersed, and class set models.

Research question 13: Are there statistically significant differences between the four models of use: full access, dispersed, class set, and mixed, when students use laptop computers and teacher evaluation of instruction with regard to homework assessment? The full access and dispersed models were significantly different as were the dispersed

and mixed models, as queried on the teacher questionnaire. Full access and mixed model teachers were more likely to elicit student ideas and opinions more often, for example, now that students used laptop computers.

Conclusions

Conclusion 1: Models of student laptop use had differential effects on teacher instructional behaviors with regard to planning, implementation of instruction, and evaluation of instruction. For example, the role of both students and teachers became more constructivist when students had access to laptop computers in the full access and mixed models. Instructional activities became more constructivist in the full access and mixed models as did assessment practices in the full access and mixed models of use. Teachers were more likely to place students in small groups in the dispersed model. In the mixed model, teachers became more collegial and used technological resources and materials more often when they engaged in planning. When student use of laptop computers was integrated into teacher instructional behaviors, teacher practice was affected. Teachers were more likely to employ a constructivist approaches in the classroom.

Conclusion 2: The full access and mixed models of use were more likely to advance constructivist instructional practice in the classroom than either the class set or dispersed models of use. Teachers working in the full access and mixed models, for example, perceived themselves as learning along with students more often. Moreover, they utilized pedagogy conducive to a constructivist approach in the classroom such as cooperative learning more frequently than teachers in the class set or dispersed models of

use. In both the full access and mixed models, students and teachers were more collegial and collaborative than teachers working in the class set and dispersed models of use. Thus, the greater impact of the full access and mixed models of use illustrates the relationship between models of student laptop computer use and teacher instructional behaviors.

Conclusion 3: The full access and mixed models of use are more likely to promote constructivist evaluation of instruction than either the class set or dispersed models of use. Constructivist assessment tasks such as students conferencing with their peers about their work, explaining their thinking in writing or in discussion, or presenting as part of a group were practiced more frequently by teachers in the full access and mixed models of use. Likewise, these same teachers were more likely to elicit student ideas and opinions or keep student items in a portfolio with greater frequency than teachers in the class set or dispersed models of use. Thus, the greater impact of the full access and mixed models of use illustrates the relationship between models of student laptop computer use and teacher instructional behaviors with regard to evaluation of instruction.

Conclusion 4: Planning was more demanding of teachers in the mixed model of use than in either the full access, class set, or dispersed models. Teachers in the mixed model of use spent more time planning and planned more frequently. However, the increased demands of planning created by the mixed model of use, may also be responsible for the greater degree of teacher collegiality and use of technological resources evident in this model of use. Not only did the mixed model of use produce a greater impact on teacher instructional behaviors with regard to planning than the full

access, class set, and dispersed models of use, but it also illustrated the relationship between models of student laptop computer use and teacher instructional behaviors with regard to planning.

Recommendations for Further Study

As a result of the numerous findings in this study and the subsequent conclusions, four recommendations for further study emerged.

1. Conduct a quasi-experimental study comparing teacher instructional behaviors with regard to implementation of instruction when students use laptop computers in a full access model to teacher instructional behaviors with regard to implementation of instruction when students do not use laptop computers.
2. Conduct a quasi-experimental study comparing teacher instructional behaviors with regard to implementation of instruction when students use laptop computers in a full access model to teacher instructional behaviors with regard to implementation of instruction when students use laptop computers in a mixed model.
3. Conduct a qualitative study designed to investigate the instructional practice and strategies in the classroom in a school where the mixed model of use has been adopted.
4. Conduct a qualitative study designed to investigate the instructional practice and strategies in the classroom in a school where the full access model of use has been adopted.

APPENDIX A

TEACHER QUESTIONNAIRE

TEACHER QUESTIONNAIRE

NOTE: Thank you for making time in your busy day to complete this questionnaire. I would like to learn about how your students' use of laptop computers has impacted your instructional practice, specifically your planning, implementation of instruction and evaluation of instruction. Your responses are anonymous and no names will be used in any reports or articles resulting from this data. Thank you. Barbara Ashmore, M.Ed.

I. Planning for Instruction

Think back and visualize the time when you planned instruction for students who *did not* use laptop computers in the classroom. Now consider your planning when students use laptop computers and respond to the following statements.

	Strongly Disagree 1	Disagree 2	Somewhat Agree 3	Agree 4	Strongly Agree 5
1. I spend more time planning now that students use laptop computers.	1	2	3	4	5
2. I plan more frequently now that students use laptop computers.	1	2	3	4	5
3. Planning has become more complex (complicated) now that students use laptop computers.	1	2	3	4	5
4. I consult with my colleagues more often now that students use laptop computers.	1	2	3	4	5
5. Planning has become more difficult (harder) now that students use laptop computers.	1	2	3	4	5
6. I have to revise my plans more often now that students use laptop computers.	1	2	3	4	5
7. I use technological resources and materials more often now that students use laptop computers.	1	2	3	4	5

FILL IN-THE-BLANKS:

8. Now that I teach students who use laptop computers, I spend, on average, _____ hours each week planning instruction.

9. Before teaching students who use laptop computers, I spent, on average, _____ hours each week planning.

II. Implementation of Instruction

Many components comprise a teacher's implementation of instruction, which frequently overlap. Please consider the components below and respond to the statements regarding your implementation of instruction when students use laptop computers.

	Strongly Disagree 1	Disagree 2	Somewhat Agree 3	Agree 4	Strongly Agree 5
10. *Student grouping:* In class(es) where my students use laptop computers. . . .					
a Students work in *small groups* on projects, assignments or presentations as a team more often.	1	2	3	4	5
FILL IN-THE-BLANKS:					
b. Now that I teach students who use laptop computers, on average, students work in groups _____ times each week.					
c. Before working with students who use laptop computers, on average, students worked in groups _____ times each week.					
11. *Instructional strategies*: In class(es) where my students use laptop computers. . . .					
a. I engage in whole class instruction more often	1	2	3	4	5
b. I engage in direct teaching/lecture more often.	1	2	3	4	5
c. I emphasize analyzing and interpreting information with students more often..	1	2	3	4	5
d. I emphasize organizing, summarizing or displaying information with students more often.	1	2	3	4	5
e. I engage in guiding/facilitating student learning more often.	1	2	3	4	5
f. I use cooperative learning more often.	1	2	3	4	5
g. Students work in *small groups* on problems for which there are several appropriate answers more often.	1	2	3	4	5
h. Students work on problems in *small groups* for which there are several appropriate methods of solution more often.	1	2	3	4	5
FILL IN-THE-BLANKS:					
i. On average, I teach students who use laptop computers as a whole class _____ times each week.					
j. Before working with students who use laptop computers, on average, I taught students as a whole class_____ times each week.					
12. *Instructional content:* In class(es) where my students use laptop computers. . . .					
a. I am able to teach a very large number of topics (themes, units, chapters, etc.) more often.	1	2	3	4	5
b. I am able to teach a large number of topics (themes, units, chapters, etc.) covered in some depth more often.	1	2	3	4	5

II. Implementation of Instruction (cont.)

Many components comprise a teacher's implementation of instruction, which frequently overlap. Please consider the components below and respond to the statements regarding your implementation of instruction when students use laptop computers.

	Strongly Disagree 1	Disagree 2	Somewhat Agree 3	Agree 4	Strongly Agree 5
13. *Teacher and student roles:* In class(es) where my students use laptop computers. . . .					
a. I learn along with my students more often.	1	2	3	4	5
b. Students carry responsibility for their learning more often.	1	2	3	4	5
c. Students suggest or plan classroom activities more often.	1	2	3	4	5
d. Students work as independent learners more often.	1	2	3	4	5
14. *Assignments and learning tasks*: In class(es) where my students use laptop computers. . .					
a. I assign a task(s) where there is no indisputably correct answer—where the truth is complex and perhaps impossible to know more often.	1	2	3	4	5
b. I assign a task(s) where there is one, possibly two correct answers more often.	1	2	3	4	5
15. *Instructional activities:* In class(es) where my students use laptop computers. . . .					
a. Students create, update or maintain a personal website more often.	1	2	3	4	5
b. Students create or contribute to school's and/or class's website more often.	1	2	3	4	5
c. Students contribute to school's and/or class's publications more often.	1	2	3	4	5
d. Students access online databases, reference materials, newspapers, periodicals, etc. more often.	1	2	3	4	5
e. Students access online libraries more often.	1	2	3	4	5
f. Students run models electronically more often.	1	2	3	4	5
g. Students play educational games/simulations electronically more often.	1	2	3	4	5
h. Students engage in virtual field trips more often.	1	2	3	4	5
i. Students use email to communicate with other students more often.	1	2	3	4	5
j. Students use email to communicate with experts in a particular field more often.	1	2	3	4	5
k. Students use an electronic bulletin board to discuss academic content, issues, assignments more often.	1	2	3	4	5
l. Students create, add to or maintain electronic journals more often.	1	2	3	4	5

II. Implementation of instruction (cont.)

Many components comprise a teacher's implementation of instruction, which frequently overlap. Please consider the components below and respond to the statements regarding your implementation of instruction when students use laptop computers.

	Strongly Disagree 1	Disagree 2	Somewhat Agree 3	Agree 4	Strongly Agree 5
15. *Instructional activities:* In class(es) where students use laptop computers. . . .					
m. Students create, add to or maintain electronic portfolios more often.	1	2	3	4	5
n. Students do projects which may/not include graphic art and design electronically more often.	1	2	3	4	5
o. Students do photographic art/design electronically more often.	1	2	3	4	5
p. Students explain how what they learned in class related to the real world more often.	1	2	3	4	5
q. Students work on projects that take one (1) week or more to complete more often.	1	2	3	4	5
r. Students apply concepts or principles to different or unfamiliar situations more often.	1	2	3	4	5
s. Students work on a project, gather data, conduct an experiment or research project more often.	1	2	3	4	5
t. Students complete routine exercises or problems from a worksheet, workbook or text more often.	1	2	3	4	5
u. Students design their own problems to solve more often.	1	2	3	4	5
v. Students decide on their own procedures for solving a complex problem and then discuss amongst themselves their different procedures and results more often.	1	2	3	4	5
w. Students represent the same idea or relationship in more than one way—e.g., in math, a table and a graph; in English by poem and essay more often.	1	2	3	4	5
x. Students relate what that are working on to their own experiences more often.	1	2	3	4	5

III. Evaluation of Instruction

There are many possible evaluation/assessment tasks of instruction. Please consider and respond to the evaluation/assessment tasks listed below regarding how you evaluate/assess students when they use laptop computers.

	Strongly Disagree 1	Disagree 2	Somewhat Agree 3	Agree 4	Strongly Agree 5
16. When *assessing* students who use laptop computers, I have students' complete tasks. . . .					
a. evaluate and improve their own work more often.	1	2	3	4	5
b. evaluate and improve their own work as a result of peer feedback more often.	1	2	3	4	5

III. Evaluation of Instruction (cont.)

There are many possible evaluation/assessment tasks of instruction. Please consider and respond to the evaluation/assessment tasks listed below regarding how you evaluate/assess students when they use laptop computers.

	Strongly Disagree 1	Disagree 2	Somewhat Agree 3	Agree 4	Strongly Agree 5
16. When *assessing* students who use laptop computers, I have students' complete tasks. . . .					
c. write and essay or hold a serious discussion assessing their own work on a paper or project--- what they did well, how they could improve, etc. more often.	1	2	3	4	5
d. present as part of a group on projects or presentations to earn *individual* grades more often.	1	2	3	4	5
e. present as part of a group on projects or presentations to earn *group* grades more often.	1	2	3	4	5
f. put events or things in order and explain why they are organized in that way more often.	1	2	3	4	5
g. discuss with the whole class solutions developed in small groups more often.	1	2	3	4	5
h. confer with other students about their work more often.	1	2	3	4	5
i. write an essay or paper in which they are expected to explain their thinking more often.	1	2	3	4	5
j. respond orally to teacher generated open-ended questions more often.	1	2	3	4	5
k. present as individuals, oral reports to the whole class more often.	1	2	3	4	5
l. prepare a research paper on an assigned or approved topic more often.	1	2	3	4	5
m. make a product that will be used by someone else more often.	1	2	3	4	5
n. demonstrate their work to an audience including people other than from the school or their family more often.	1	2	3	4	5
o. take a test or quiz for a full period more often.	1	2	3	4	5
p. take a test or quiz for more than a full period more often.	1	2	3	4	5
q. students explain how what they learned in class related to the real world more often.	1	2	3	4	5

FILL IN-THE-BLANKS:

r. Now that I teach students who use laptop computers, on average, students are involved in assessment assignments that are authentic in nature_____ times each grading period. A grading period is _____ weeks.

s. Before working with students who use laptop computers, students were involved in assessment assignments that were authentic in nature _____ times each grading period. A grading period was _____ weeks.

Background Information: The following information will be used to describe this sample.

☑ ***ONE. In my school, I teach students who have access to laptop computers in one of the following models:***

_____ *Full access model* is one in which each student has a laptop computer for his/her use at all times, both at school and home.

_____ *Dispersed model* is one in which laptop computers are dispersed throughout a grade or school so that in any given class, there will be students with laptop computers and students without laptop computers. Students with laptop computers may use them at home and school.

_____ *Class set model* is one in which a school or school district has sets of laptop computers available so that teachers can check out a set of laptop computers for student use for specific time periods. (Students may or may not be able to take laptop computers home for use.)

_____ *Scattered model* is one in which a school or school district has distributed a few laptop computers to each classroom with little opportunity for students to take the laptop computers home.

_____ *Mixed model* is one in which a school or school district combines two of the four models either within or between schools in the district.

_____ *Other:* _____
please specify.

☑ ***ONE*** : I teach in a
_____ public school
_____ private independent school
_____ Diocesan parochial school
_____ private independent parochial school
_____ other: _____

☑ ***ONE: Gender*** ***Age:*** _____
___ Male
___ Female

☑ ***ONE: Highest degree held:***
_____ BA/BS
_____ BA +30
_____ MA/MS
_____ MA +30
_____ Ed.D./Ph.D.
_____ Other (please specify) _____

☑ ***ONE: Years teaching students with laptop computers:***
_____ 0 – ½ _____ ½ - 1
_____ 1 – 1.5 _____ 1.5 – 2
_____ 2 – 2.5 _____ 2.5 - 3
_____ 3 – 3.5 _____ 3.5 - 4
_____ 4 – 4.5 _____ 4.5 - 5
_____ 5 – 5.5 _____ 5.5 - 6

☑ ***ONE: Ethnicity***
_____ African-American
_____ Asian-American
_____ Latino/Hispanic-American
_____ White (other than Latino)
_____ Other (please specify): _____

☑ ***ONE. How many years have you taught?***
_____ 0 – 5 _____ 6 - 10
_____ 11 - 15 _____ 16 - 20
_____ 21 +

Thank you for taking the time to complete this questionnaire.

III. Evaluation of Instruction (cont.)

There are many possible evaluation/assessment tasks of instruction. Please consider and respond to the evaluation/assessment tasks listed below regarding how you evaluate/assess students when they use laptop computers.

	Strongly Disagree 1	Disagree 2	Somewhat Agree 3	Agree 4	Strongly Agree 5
17. When *assessing homework activities* of students who use laptop computers, I					
a. see if students know the correct answer more often	1	2	3	4	5
b. see if students have done the homework. more often	1	2	3	4	5
c. elicit students' ideas and opinions more often.	1	2	3	4	5
d. record only whether the assignment was completed more often.	1	2	3	4	5
e. collect, correct and keep assignments more often.	1	2	3	4	5
f. keep items in a student portfolio more often.	1	2	3	4	5
g. collect, correct and return assignments to students more often.	1	2	3	4	5
h. have students exchange assignments and correct them in class more often.	1	2	3	4	5
i. have students correct their own assignments in class more often.	1	2	3	4	5
j. use assignments as a basis for class discussion more often.	1	2	3	4	5
k. use assignments as a basis for grading students more often.	1	2	3	4	5
l. use assignments as basis for lesson planning more often.	1	2	3	4	5
18. When *grading* students who use laptop computers, I give ***MORE* importance to. . . .**					
a. effort.	1	2	3	4	5
b. individual improvement.	1	2	3	4	5
c. absolute level of achievement.	1	2	3	4	5
d. achievement relative to the rest of the class	1	2	3	4	5
e. class participation.	1	2	3	4	5
f. regular completion of homework assignments.	1	2	3	4	5
g. consistent attendance.	1	2	3	4	5
h. results of test with open-ended items.	1	2	3	4	5
i. results of test with multiple-choice or true-false items made by you or other teachers.	1	2	3	4	5
j. performance on projects or practical exercises	1	2	3	4	5
k. my own observation of students.	1	2	3	4	5

For the statements that follow, please *compare* and *reflect upon* the performance and accomplishments of your students who use laptop computers and the performance and accomplishments of your students when they did not use laptop computers.

The word *better* means that student use of laptop computers facilitates and improves the *quality of student performance.*

	Strongly Disagree 1	Disagree 2	Somewhat Agree 3	Agree 4	Strongly Agree 5
19. *In your opinion*, students who use laptop computers. . . .					
a. master skills just taught *better* than students who did not use laptop computers more often.	1	2	3	4	5
b. remediate skills not learned well *better* than students who did not use laptop computers more often.	1	2	3	4	5
c. express themselves in writing *better* than students who did not use laptop computers more often.	1	2	3	4	5
d. communicate with other people *better* than students who did not use laptop computers more often.	1	2	3	4	5
e. find out about ideas and information *better* than students who did not use laptop computers more often.	1	2	3	4	5
f. analyze information *better* than students who did not use laptop computers more often.	1	2	3	4	5
g. present information to an audience *better* than students who did not use laptop computers more often.	1	2	3	4	5
h. learn to work collaboratively *better* than students who did not use laptop computers more often.	1	2	3	4	5
i. learn to work independently *better* than students who did not use laptop computers more often.	1	2	3	4	5

20. COMMENTS: What would you like to tell me about your instructional practice that I have not asked?

APPENDIX B

PROFILE DESCRIPTION OF EACH MODEL OF USE

Table B1

Statistical Profile of Models of Use

Dependent Variable	M	SE	Std. Dev.	Variance
Full Access Model (N = 89)				
PLN	3.10	.0083	.78	.62
GRP	3.00	.1217	1.15	1.32
I-STR	2.97	.0083	.78	.61
I-CON	2.77	.1096	1.03	1.07
T/S-R	3.41	.0083	.78	.61
A/L-TKS	2.90	.0098	.92	.85
I-ACT	3.14	.0064	.60	.36
ASMT TKS	2.96	.0074	.70	.49
HW	2.65	.0082	.77	.60
GRDG	3.00	.0091	.86	.73
Dispersed Model (N = 89)				
PLN	3.25	.1001	.94	.89
GRP	3.58	.0089	.87	.70
I-STR	2.70	.1093	1.03	1.06

(table continues)

Dependent Variable	M	SE	Std. Dev.	Variance
Dispersed Model (N = 89)				
T/S-R	3.02	.1076	1.02	1.03
A/L-TKS	2.61	.1101	1.04	1.08
I-ACT	2.67	.0087	.82	.67
ASMT TKS	2.55	.0092	.87	.75
HW	2.27	.0084	.79	.63
GRDG	2.82	.1020	.96	.93
Class Set Model (N = 89)				
PLN	3.06	.0086	.81	.66
GRP	3.24	.1130	1.066	1.14
I-STR	2.79	.0076	.71	.51
I-CON	2.64	.0079	.75	.56
T/S-R	3.24	.0088	.83	.69
A/L-TKS	2.77	.0097	.92	.84
I-ACT	2.81	.0082	.78	.61
ASMT TKS	2.80	.0073	.69	.48
HW	2.44	.0073	.72	.52

(table continues)

Dependent Variable	M	SE	Std. Dev.	Variance
Mixed Model (N = 89)				
GRDG	2.71	.0076	.72	.52
PLN	3.42	.0061	.58	.33
GRP	3.33	.1105	1.04	1.09
I-STR	3.12	.0056	.53	.28
I-CON	3.07	.0075	.70	.50
T/S-R	3.52	.0076	.72	.52
A/L-TKS	2.93	.0088	.83	.69
I-ACT	3.18	.0063	.59	.35
ASMT TKS	3.00	.0048	.45	.20
HW	2.63	.0065	.62	.38
GRDG	3.29	.0038	.36	.13

Note. PLN = planning; GRP = grouping; I-STR = instructional strategies; I-CON = instructional content/subject matter; T/S-R = teacher and student roles; A/L-TKS = student assignments and learning tasks; I-AVT = instructional activities; ASMT TKS = assessment tasks and activities; HW = assessing homework; GRDG = grading

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